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VALIDITY AND RELIABILITY OF A FOOD FREQUENCY QUESTIONNAIRE

by

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DEDICATION

I wish to dedicate this paper to:

Steven M. Bradley

and

Sarah A. Edmonds

with love

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INTRODUCTION

As the evidence for a relationship between dietary habits and disease has accumulated there has been increased interest in the food frequency questionnaire . Researchers, have begun to seek a method which can rapidly assess the nutritional status of groups of individuals. Short-cut methods for calculating the nutritional adequacy of diets have been developed (1,2,3). Yet, these short-cut methods of calculation still employ the use of conventional dietary instruments, such as the 24-hour dietary recall or the diet history which are tedious and time consuming. The rapidity of computer calculations to process nutritional data has far surpassed the expediency of other methods. These short-cut methods have not filled the need. Clearly, what is needed is a computerized instrument that is easy to administer or can be self-administered. Work in this area has accelerated in the 1980's.

The food frequency has advantages over other conventional instruments. It eliminates the laborious procedures of weighing and recording food intake. It does not rely heavily on the memory of individuals; they are

asked only to remember the frequency with which foods are consumed, not amounts. Before such an instrument can be used there must be sufficient evidence of its validity and reliability.

Validity is "An expression of the degree to which a measurement measures what it purports to measure."(4). Validity of a dietary instrument has been investigated by weighing actual food consumption, calculating nutrient intake using standard food composition tables and comparing these values with those obtained from the instrument under investigation. Even when precise weights of foods eaten are obtained, one can not assume that this is an accurate measure of usual nutrient intake. Individuals may alter their usual eating habits when under the close scrutiny of the researcher or individuals may simply tire of the tedious procedures of weighing foods. In addition, there are times when it is not feasible to employ such time-consuming and costly methods, thus relative validity is often tested for dietary instruments. As Block (5) pointed out, "If measurement of what an individual has actually consumed is impossible to obtain, the dietary instrument in question must be validated by a method of relative validation". Relative validity may be determined by comparing the data obtained from the dietary instrument under investigation with the data obtained from a dietary instrument which has

previously been proven valid. However, one must remember that when relative validity is tested, absolute validity is not measured.

Reliability refers to "The degree of stability exhibited when a measurement is repeated under identical conditions."(4). Therefore, reliability may be measured by determining the ability of the dietary instrument to replicate the same results when it is applied under the same circumstances.

The 24-hour dietary recall has been used for collecting dietary intake data in many large-scale surveys including the Nutrition Canada National Survey and HANES II (6,7). People in most age groups and educational levels are able to recall foods eaten the day before. The 24-hour dietary recall can be administered in a relatively short period of time, and it does not require special instruction for the respondent. The 24-hour dietary recall has been found to give valid results for groups of individuals when compared with other conventional methods (8,9,10) Therefore, we chose this instrument to validate our food frequency instrument.

The purpose of this study was (a) to test the validity of a food frequency questionnaire by comparing mean energy and nutrient intakes obtained from this instrument with means obtained from 24-hour dietary recalls and (b) to test the reliability of a food frequency questionnaire by

demonstrating that the same procedure repeated after a period of time, in the same situation, will produce the same results.

If relative validity and reliability are demonstrated for the food frequency instrument by comparison with the 24-hour dietary recall, additional evidence will be provided to establish a basis for the expedient collection of dietary intake data for groups of individuals.

REVIEW OF LITERATURE

Collecting Food Consumption Data

Food balance sheets

Food balance sheets are gross indirect estimations of a nations food consumption per capita. They are based on agricultural productivity, food exports and imports, and changes in food stocks (11). These estimates are used when planning international nutrition policies, that is, as a basis for determining agricultural production and processing, for targeting population groups who may be at nutritional risk and for demonstrating changes in the nutritional status of a population group. The Food and Agriculture Organization of the United Nations (FAO) prepares Food Balance Sheets for populations in different parts of the world to give a total view of the food supply of a country or population group (12). The FAO's Food Balance Sheets are used to evaluate a country's progress towards meeting it's project objectives, to promote the production of food in various parts of the world, to encourage a more even distribution of food between different countries, and to improve nutritional status of the population. In addition, data collected over a long period

of time can show trends in quantity and quality of food consumed (12).

Food Balance Sheets provide only estimates showing total amounts of commodities available. They do not show amounts actually consumed by individuals nor do they show how the food is actually distributed within the population to the various cultural and socioeconomic groups (11,12).

Food inventories

Food inventories are comprehensive itemized lists of foods consumed over a certain period of time on a large scale basis from institutions or from small groups or families sharing a common kitchen (12). Records are kept of all food available to the common kitchen by recording the weights of all foods purchased, produced and contributed for consumption. Estimations are made for food eaten away from home and for food waste. The food remaining at the end of the study period is weighed and recorded. The total food consumption is calculated by subtracting the items remaining in the inventory at the end of the period from those listed at the beginning plus the foods acquired during the study period. Amounts are recorded by weight with a notation indicating whether determination was made by actual weighing or from purchased weight. If necessary, food items may be recorded in household measures. Recording can be done either when foods are acquired or when taken from stock.

The number of persons at each meal including visitors is recorded. The study period is most commonly two weeks to one month, although food inventories used for institutions are normally obtained annually. Families or small groups may be asked to keep daily records. These detailed accounts require the supervision of trained investigators at the beginning and end of the study period and many times during the course of the study period. Rather than calculate individual intake, this method assumes that each individual in the group has the same nutrient intake.

Dietary intake records

The dietary intake record is a written account including a complete description kept by the subject of all food and beverage consumed (13). The most common procedure is to weigh all intake, although, amount may be recorded in household measures. Individual portions are weighed before serving, and plate waste is weighed after consumption. A more precise method of recording weight is to obtain weights of all ingredients during preparation including edible waste. The record keeping period may vary from one day to several days. Records have been kept for as long as 30 days and in a few instances as long as one year. The length of record keeping period is determined by the information sought by the researchers, the amount of time and money available, the anticipated level of compliance to which the

subjects will adhere, and the number of individuals in the population sample.

St. Jeor et al.(14) looked at variability of nutrient intake over a 28 day period to determine the length of time for which records must be kept in order to determine long-term intake patterns of the nutrient intake of an individual. The mean correlation coefficient for energy and seven nutrients for the seven days compared with those of a 28 day average ranged from $r=0.84$ ($p<0.01$) to $r=0.94$ ($p<0.0$). St. Jeor concluded that "there is no advantage to collecting data beyond one week at any one particular point in time". Marr et al.(15) reported correlation coefficients for kilocalories ($r=0.84$), for protein ($r=0.72$) and for fat ($r=0.85$) when comparing seven-day weighed records of 25 bank officers administered six months apart. Again, demonstrating one week's nutrient intake is similar to another week.

St. Jeor also reported variation in dietary intake for each day of the week. This analysis indicated no significant difference for each of the days except Friday which showed a higher protein intake. Because of the low variation from day to day St. Jeor sought to determine the least number of days that would give valid data, reflective of an individuals nutrient intake. St. Jeor concluded that a four-day dietary record (that included week-end days and Monday) could be used in place of a seven-day dietary record

when it was not feasible to collect a seven-day dietary record. The four-day dietary record taken through the week-end would average in the day with the most variability. Gersovitz et al. (16) concluded that a record should not be kept for more than several days because the accuracy with which the record was keep declined considerably by day five.

Stevens et al.(9) found good agreement between the 24-hour dietary recall and the seven-day dietary record with a group of middle western Americans with above average education. They concluded that one day appeared to be sufficient to report the usual pattern of intake for a group of individuals. They did go on to say that the degree of stability depended on sex, education, age and occupation of the group under investigation.

Chalmers et al. (10) reporting the results of work done as part of the Nutritional Status Project NE-4 cooperatively by agricultural experiment station of the Northeastern Region, found in "150 analysis representing all nutrients and all population groups studied that a diet record need consist of only one day when characterizing the diet of a group." They went on to say that to obtain an estimation of the mean intake for a group with greater precision, it was more efficient to include more subjects rather than more days.

Chalmers reported that the number of days required to

obtain reliable information for an individual "would require extensive research on that particular person". Indirectly Chalmers reported in logarithmic graphs the number of days per individual required to obtain either a 95 percent or a 99 percent confidence interval for precision measured as percent of the Recommended Dietary Allowances.

McHenry et al.(17) had 31 scientist and laboratory technicians keep food records the first week of each month of each of the 12 months. The results indicated that records for one week did not represent diets for the year of a small group.

Chappell (18) weighed all food that she consumed for over one year. She concluded that there was little advantage in obtaining food consumption for more than seven days when only an average estimate of nutrients is desired. She suggested a more precise estimation could be obtained by recording three one-week records seasonally throughout the year and averaging those.

Beaton et al.(8) stated "The observation of a high intraindividual variance component implies that the precision of the estimate of an individual's usual intake, obtained from a single one-day observation, is relatively low". The reliability of the estimates can be improved if several recalls are obtained for the same individual. Beaton suggested if seeking group means to either increase the sample size or increase the number of observations. "An

increase in either will improve the quality of the information obtained." Karvetti and Knuts (19) reported that dietary data collected over long periods of time tended to estimate high dietary intakes and data collected for short periods estimated low intakes. These authors suggested developing a diet history method and a recall method suitable to cover medium-length time periods.

Dietitians may use the dietary intake records as tools to determine compliance to a prescribed diet. Program planners may use this tool for the purpose of collecting food intake data for nutritional surveillance. Epidemiologists may use the dietary intake record in combination with other dietary instruments to obtain food consumption data when seeking information on cause-effect relationships between diet and disease.

This instrument requires a certain degree of literacy and considerable motivation (12). Individuals may tire of record keeping and, hence, keep imprecise records. Not every individual is willing or able to carry out the tedious procedure required of this method. Todd et al. (20) had subjects keep taped recording accounts in weights of all foods consumed, thereby eliminating some errors due to incomplete written records. Although the taped records were preferred by the subjects, weighing of all foods is still required. Amount of foods consumed away from home must be

estimated by the subjects, thus decreasing precision.

Trulson and McCann (21) studied a small group (11= not reported) of professors with high cholesterol levels from the Massachusetts Institute of Technology. Reliability for a seven-day record was investigated by comparing correlation coefficients of data obtained in 1955 with that obtained in 1957. The authors reported the following correlations coefficients: calories = 0.43, protein = 0.43, fat = 0.33. The correlation for the percent of calories from protein, fat and alcohol were 0.36, 0.15, 0.48 respectively. A significant difference was found only in the percentage of calories from alcohol ($p < 0.02$). The authors concluded that studies with a small number of exceptionally reliable subjects were more likely to reflect food consumption for one week rather than a characteristic dietary pattern.

Tremblay et al.(22) using 61 children and adults of both sexes, demonstrated satisfactory reliability when two three-day dietary records (two week days and one week-end day) were administered seven days apart. For 11 of the 12 nutrients studied intraclass correlations were between $r=0.54$ and $r=0.86$. Only retinol showed no significant correlation ($r = -.06$) between the first and second records. Mean estimates for protein, calcium and niacin indicated significant differences. All other nutrients were similar. The authors concluded that three-day dietary records provided a reliable estimate of nutrient intake. This was

particularly true of the children whose diets were more consistent.

Researchers have demonstrated no great variation in nutrient intake form one week to the next (14,15,18). Several researchers have concluded that there is little advantage in collecting food consumption data for more than seven days when only averages of intake are sought (14,18). Good correlations have been demonstrated between a seven day dietary record and a four-day dietary record (24). Stevens et al.(9) found good agreement between a 24-hour dietary recall and a seven-day dietary record with a group of middle Western Americans with above average education. Other researchers have supported these findings (10). Trulson and McCann (21) found that for individual data the seven-day dietary record did not reflect an individual's characteristic dietary pattern. Several researchers have demonstrated reliability of dietary records (21,22) when compared to other conventional methods or to actual food intake.

Dietary histories

Dietary histories are instruments used to collect retrospective food intake information from an individual or from a group of individuals which will give qualitative data describing patterns of usual food consumption. The dietary history as a method for collecting data on usual food

consumption was first developed by Burke (23). This instrument or variations of it has been the most widely used method for collection of dietary intake data. Burke's method incorporates several approaches for gathering dietary information which will be used in the final assessment of average food intake over a given period of time. Before dietary intake is obtained the interviewer gathers background information relating to the subject's health habits and to other factors which may have contributed to the subject's current nutritional status. Next the interviewer obtains the subject's usual pattern of eating and any deviations from this usual pattern. This information is recorded in household measures by a trained interviewer. The interviewer records on a standardized form developed by Burke (23) the frequency with which specific foods are eaten as well as the amounts. Data are collected for a predetermined period of time. Reed and Burke (7) used a six month period when testing the validity and reliability of this instrument. Burke developed a "cross-check" which she believed was necessary to test the reliability of the diet history. Again, the interviewer has a standardized form, this time listing specific food groups and foods. The interviewer then questions the subject about the foods eaten from the list and the usual amount consumed. At the same time the information obtained during the first interview is

verified and clarified. The diet history interview takes about one hour. The information obtained in these two interviews gives a representative picture of the subject's average intake for the interval.

There have been a number of adaptations of the Burke's Diet History. For example Bryan and Anderson (24) developed a diet history interview which focused on an infant's intake of vitamin D from birth to six years of age. The interview was divided into two sections, the first obtained dietary intake data from six years of age back to the time of weaning and the second obtained dietary intake data from birth to weaning. After each section was completed the informant listened while the interviewer repeated the information just collected. All interviews were tape recorded and then reviewed by the interviewer as the "cross-check" in this study.

The diet history method relies on the memories of the participants as well as their ability to estimate amounts of foods they have eaten (12). Not every group of individuals would be capable of remembering past food consumption. When dietary histories are used to collect information on small children and infants, information is obtained from the mother or person who has been responsible for providing food for that child. The administration of the dietary history instrument requires the expertise of a trained interviewer. Not only must the interviewer know the correct procedure for

obtaining the information, he or she must have the ability to gain the confidence of the subject and to elicit correct information .

Researchers may use a dietary history to measure usual dietary intake (25). When usual dietary intake reflects an individual's long standing dietary patterns, clues, such as low intakes of specific nutrient, may be found explaining clinical signs and symptoms of presently observable nutrient deficiencies or food related diseases (21). The dietary history can also be used to quantify specific food items or specific nutrients in a diet. The National Nutrition Survey in Canada administered a dietary history in this way to assess non-nutritive additives to food (6). Bryan and Anderson (24) used a dietary history to gather quantitative estimations of the average daily intake of milk in ounces and of Vitamin D in international units for 163 children for the previous six years of their life.

Lubbe (26) tested the validity of a modified diet history by comparing the diet history with a weighed seven-day record completed by 99 children. The method was modified in that the interview took place in the subject's home to emphasize the informality of the interview. Not only was the informant for the child interviewed, but also supplementary information was obtained from another household member. Accurate amounts consumed by the individual were determined

by weighing, instead of recording in household measures. Lubbe concluded that the results obtained from the modified diet history were as satisfactory as the results obtained with the weighed records.

Karvetti and Knuts (19) found the intraclass correlation to be in better agreement between the diet history and the seven-day dietary recall than between the diet history and the 24-hour dietary recall one year after myocardial infarction (n = 86). The ranges of the correlations were 0.62 to 0.90 and 0.50 to 0.67, respectively. The same pattern was observed when data were obtained two years after myocardial infarction (n = 77). The ranges of the correlations were 0.69 to 0.86 and 0.35 to 0.70, respectively. The diet history interview obtained one and two years after myocardial infarction gave higher nutrient intake values than the 24-hour dietary recall or the seven-day dietary recall. There were considerable differences between the methods, but the differences were consistent and in the same direction. The authors concluded that the coherence between the results makes it reasonable that the different dietary interview methods can be used in nutrition studies when it is kept in mind that the results are not directly comparable with one another.

A number of investigators have found that the diet history yields higher values than do the seven-day dietary records (27,28,29). Young et al. (30,31,32,33) in a number

of investigations, with 49 to 164 subjects per study group, reported that the diet histories estimated a higher mean intake than did the unweighed seven-day dietary records or the 24-hour dietary recalls. However, several other studies (21,34) found no significant difference between the diet history and a seven-day dietary record when repeated values were obtained within two years. Morgan et al. (6) suggested that the diet history as an instrument for obtaining usual diet patterns of a group of individual is of greater value than generally appreciated. Huenuman and Turner (35) compared means obtained from 25 children from 10 to 14-day dietary records with those obtained from diet histories. They found that for most of the nutrients studied the means given by the two methods were within plus or minus twenty percent of each other.

Jain et al. (29) studied the validity of the diet history using 20 pairs of university staff members who kept records for 30 days. A partner system was used to increase compliance. Each person recorded the food consumption of their partner. Within one week of completion of the food records, the participants completed a diet history interview based on the 30-day dietary record. The mean daily intakes for the group tended to be higher for the diet history than the records. The diet history correlated well with the 30-day dietary record for seven of the 13 nutrients considered.

The correlations ranged from 0.63 to 0.24 with the highest correlations being for total fat, vitamin C, saturated fat, oleic acid, cholesterol, vegetable protein and animal fat. The authors concluded that with large numbers of participants in epidemiological studies the diet history can be used, although it gives only a "similar picture" of nutrient intake as compared with the 30-day dietary record.

Van Staveren et al. (36) compared a current diet history administered in 1976 with a current diet history and a retrospective diet history administered in 1983. Forty four men and 58 women completed three diet histories each of which covered a six month period. The mean values were higher for the 1983 retrospective diet history than for the current diet history administered in 1976 for all nutrients except cholesterol and alcohol. The 1983 current diet history correlated better with the 1976 current diet history than did the 1983 retropsective diet history. The results suggested that actual changes in food consumption are smaller than reported changes. The data obtained from the 1983 retrospective diet history correlated well with the current diet history suggesting that current intake habits did effect the reporting of food intake. Van Staveren concluded that a current diet history is a better indicator of past food intake than a retrospective diet history.

Trulson and McCann (21) obtained diet histories from 180 Italian-American men employed by B.F.Goodrich Co. in

Watertown, Massachusetts in 1956 and again in 1958 from 39 of these same men, (a twenty per cent sample). The diet histories obtained for the two periods studied were compared for mean intake of calories, grams of fat, protein and alcohol. The differences between the means were not significant. Correlations between the means varied from 0.5 to 0.6, demonstrating reliable group data. Trulson and McCann concluded that the diet history was a satisfactory method for obtaining reasonably accurate information of food intake, but doubted if it could be considered characteristic, "if by characteristic we mean the individual will show no more than a plus or minus ten percent variation in the least variable nutrient."

Jain et al. (29) tested the reliability of a diet history by administrating two interviews six months apart with 26 cancer study subjects and 26 controls. High correlations were obtained for most nutrients within the control group. The cancer subjects demonstrated lower correlations, possibly due to changes in diet caused by their disease.

Dawber et al. (34) while conducting interviews for the Farmingham studies on cardiovascular disease investigated the reliability of a modified diet history. They included an unstructured interview in which the subjects responded by giving their usual daily frequency of food intake. The diet

history was obtained at two year and four year intervals by both the same nutritionist and a different nutritionist. The authors considered the correlation coefficients of 0.5 to 0.8 for the sequential estimates of dietary factors to be satisfactory. Young (37) summarized Dawber's data, saying that the values for various nutrients and for total calories were remarkably similar when the interviews were two years apart. This was true whether given by the same nutritionist or a different nutritionist. When the time interval increased to four years, significant differences were found in the values of total calories and in many of the nutrients as determined by the same nutritionist. Block (5) was doubtful as to whether or not all the necessary information had been elicited that would be required for Dawber's study. Block also felt that interview bias may have existed regarding the persistency and depth of the probing used. Young (37) suggested that the change in reliability may be due to intentional changes in dietary habits on the part of the subject.

Reshef and Epstein (38) tested the reliability of a diet history with 60 subjects 40 years of age or older. Subjects were born either in North Africa or Europe. Trained nutritionists interviewed the subjects two different times, six and a half to eight and a half months apart. The mean number of food items eaten was used to measure variability of the diet. The mean number of food

items eaten was found consistent between interviews and remained consistent whether reported by sex and by country of birth groups. Reshef and Epstein measured the extent to which variability of the diet affected reliability by dividing the subjects into three groups according to the number of different food items eaten (< 45 items, 45 to 59 items, and 60 >). In each of the three groups there was no significant differences between the first and second interview. Epstein et al. (39) in an earlier study found that variability of the diet increased as the number of food items increased.

Young et al. (30) found that the intake of an individual could be predicted from a seven-day dietary record or a seven-day dietary history. Several researchers (26,29,35) found that the diet history as well as the seven-day dietary record could classify individuals by levels of various nutrient intake. Trulson and McCann (30) concluded that for the individual the diet history may not be a reliable instrument. They found no significant difference for group means of protein, fat, and alcohol, but when they examined the percentage of calories, coming from protein, fat, and alcohol, the correlation between the administrations of the diet history was 0.25,0.62, and 0.61 respectively. The low correlation for protein demonstrates a difference in food intake between repeated diet histories.

The diet history instrument has been one of the most widely used methods for obtaining retrospective dietary intake information. It has been accepted generally to give valid and reliable dietary intake data for certain groups of individuals. Researchers (21,31,34) have compared group means obtained from a diet history with group means obtained from dietary records demonstrating good agreement between the two methods. Others have found no significant differences between means obtained by the two methods (21,34). Karvetti and Knuts (19) found fair agreement between the diet history and the 24-hour dietary recall method with correlations ranging from 0.35 to 0.70 for the various nutrients studied. Numerous researchers (19,27,28,29,31,32,) have found that the diet history gave higher mean values than diet records or 24-hour dietary recalls.

Upon repeated administration, the diet history has demonstrated good reliability. When comparing mean nutrient values obtained from repeated diet histories researchers have found correlations ranging from 0.5 to 0.8 (23,21,29,36,38) Van Staveren et al. (36) concluded that actual changes in food consumption as reported by the diet history are smaller than reported changes.

<u>24-hour dietary recall</u>

The 24-hour dietary recall is an instrument used to

collect dietary intake data from individuals or groups of individuals for the 24-hour period prior to the interview. The subject is asked to start with the meal they remember best which is most likely the last meal consumed or the first meal consumed (breakfast). Usually breakfast is easiest to recall because it is relatively consistent. The trained interviewer then asks probing questions to facilitate the memory of the subject. The amounts consumed are reported in household measures. The interviewer may use aids, such as food models, photographs, or various standard household measuring devices such as glasses, measuring cups, spoons, rulers, to help the subject estimate portions.

The 24-hour dietary recall has been the instrument of choice for large-scale nutrition surveys for collecting dietary data (7). This instrument does give fairly accurate descriptions of the distribution of usual dietary intake of a population (11,30,40,41). Gutherie and Scheer (1) felt that the 24-hour dietary recall was a valuable aid in evaluating the effectiveness of a dietary intervention program or the dietary adequacy of a target group. The data collected from a single 24-hour dietary recall may not accurately reflect an individual normal's day intake. However, Balogh et al. (42) have reported that it is a valuable aid in the "difficult and complex area of classifying individual dietary intake". Individuals have days when they consume more or less than they usually do.

Gersovitz et al. (16) found that small intakes tend to be over-reported and large intakes under-reported. Other researchers have found evidence to support these findings (43,44).

Linusson et al. (44) studied the validity of a 24-hour dietary recall by weighing all foods served for three consecutive meals to 86 lactating women confined to a hospital. Linusson analyzed the data by categorizing food items eaten into 14 food groups. For eight of the 14 food groups the mean taken from the 24-hour dietary recall was significantly different ($p < 0.05$) than the mean for the actual intake. Regression analysis showed characteristics of the flat slope syndrome. i.e., the slope coefficients for the 14 food groups were less than one indicating an overestimation of small quantities and underestimation of large quantities of foods consumed. The range was from 0.24 to 0.89. The authors concluded that the 24-hour dietary recall was a valid instrument to identify trends in food patterns of large groups. Investigating internal validity the authors concluded that the 24-hour dietary recall gives a fairly accurate estimate of group values for qualitative intakes but less accurate for estimates of quantities consumed.

Morrison et al. (45) asked eight scientists to weigh their food intake for one day. They found, that for group

averages, the 24-hour dietary recalls were similar to the weighed values. However, The weighed records kept for the previous 24 hours may have influenced the results obtained by the 24-hour dietary recall.

Madden et al. (43) tested the validity of 24-hour dietary recall data in elderly, non-institutionalized subjects. Trained observers watched unobtrusively for plate waste which was then subtracted from the average weights of each serving. Twenty four-hour dietary recalls were obtained the following day. Seventy-six subjects 60 years of age and older were interviewed. The paired-t test demonstrated no significant differences between the means obtained from the recalls and the means obtained from actual intake of protein, calcium, iron, vitamin A, thiamin, riboflavin, and ascorbic acid. The only exception was calories which were underestimated on the 24-hour recalls. Regression analysis indicated that a highly significant ($P < 0.01$) relationship existed between actual and recall values. For three of the eight nutrients reported (calories, protein, vitamin A) the flat slope syndrome appeared, i.e., small quantities tended to be over-reported and large quantities tended to be under-reported. The 24-hour dietary recall underestimated actual mean intake for calories for a group of elderly persons. The authors concluded that the 24-hour dietary recall provided a good estimate of the group's mean intake for seven of eight nutrients examined.

For nutrients identified in the regression analysis, calories, protein and vitamin A, the recall seemed to be statistically conservative for group comparisons. Thus the recall would seldom, if ever, indicate a difference in intake where no differences exists. They went on to say however, that the 24-hour dietary recall could yield a false negative, that is an indication of no significant difference, when in fact a difference does exist.

Gersovita et al. (16) unobtrusively recorded the noon meal of elderly subject's at a congregate meal site. Forty-four subjects with an average age of 71.7 years completed a 24-dietary recall administered at three and a half hours or at 24 hours after the congregate meal. The mean nutrient intakes determined by the recall gave higher values than actual mean intakes for all nutrients except vitamin A. Only for protein was the difference between recall and actual intakes significant ($p<0.05$). The authors concluded that the 24-hour dietary recall yielded a relatively valid estimate of the food mean intake of a group of elderly subjects.

Gersovitz's study confirmed Madden's findings, with the exception of energy and protein. Madden found that the 24-hour dietary recall underestimated energy which Gersovits found that it over estimated. These differing results could have been due to the differences in design of the two

studies. Madden did not obtain actual weight of foods consumed for each individual, but assumed that each individual ate the pre-measured portion served. Ohlson et al. (46) tested the validity of a 24-hour dietary recall with 18 women and found that calorie intake was higher when calculated from the 24-hour method than from weighed records.

Carter et al. (47) sought to determine the validity of the 24-hour dietary recall with 28 children between 10 and 12 years of age who were attending a summer camp for children with chronic diseases. Observed intakes were recorded for five subjects in one day. Paired-t test and multiple regression analysis were completed for caloric values and protein intakes. Again, the results demonstrated the "flat-slope syndrome". A large significant difference was found between recall and observed intakes for both calories and protein. The authors concluded that the recall method was not valid for measuring caloric and protein intakes in the study population.

Stevens et al. (9) collected 225 24-hour dietary recalls and 97 dietary histories from 74 subjects. The subjects were divided into five groups: younger women, younger men, pregnant women, older women, and older men. All subjects were Caucasian, middle-western Americans with above average education. The purpose of the study was to investigate the differences between the two methods by

comparing 55 nutrient values. The group nutrient values for the two methods were within 20 per cent of each other for 47 nutrients. Group values were closer for the younger women and older men than the other groups. The two methods gave similar results for groups of "informed" persons. The authors concluded that these methods could be used interchangeably. Young et al. (30) failed to demonstrate agreement between the diet history and 24-hour dietary recall. She group means were significantly higher for grade school children and pregnant women using the diet history. The diet history and the 24-hour dietary recall were in better agreement for the college students even though the 24-hour dietary recall gave lower overall values for this group. Young concluded that the two methods gave inconsistent results. Other studies (5,12,42,) have also failed to demonstrate agreement between the two methods.

Morgan et al. (6) attempted to develop a standardized procedure to collect past dietary intake that also would reflect current diets. An assumption was made that individual dietary patterns have sufficient constancy to allow recent intake to serve as an indicator of prior practices. Such a method would be useful in epidemiological studies to investigate the relationship between diet and disease. The study consisted of four groups, each from a different area in Canada, and each of 100 individuals. All

subjects completed two diet histories, (one for the last two months and one for the two months prior to the previous six months), a 24-hour dietary recall, and a four-day dietary record. To complete the two diet histories, the participants were asked to describe the kinds of foods they had eaten, frequency of consumption in a day, week, or month, food preparation procedures and amounts consumed. The diet histories and a 24-hour dietary recalls were taken by trained interviewers to familiarize the respondent with diet record keeping procedures. Mean values and standard errors for the daily intake of calories, total fat, saturated fat, oleic acid , linoleic acid , cholesterol were obtained. The diet histories produced higher estimations of average daily intakes than either the 24-hour dietary recall or the four-day record. The four-day dietary record gave higher average daily intakes than the 24-hour dietary recall except for saturated fat in one study group and linoleic acid in another. Simple correlation coefficients between the various nutrients were calculated for each nutrient. Morgan reported that the correlation coefficients were very similar for each method, all nutrients being highly correlated. The present history was better correlated with the 24-hour dietary recall and four-day record than the past history suggesting that when directed to the same period of time all measure the same thing although the estimates vary in quantity.

Young et al. (30) found that unlike the diet history, the seven-day dietary record gave similar group values to the 24-hour dietary recall. Young concluded that under certain circumstances, the 24-hour dietary recall can be substituted for the seven-day dietary record in the analysis of group data.

Morgan et al. (6) compared the mean calorie intake obtained from the 24-hour dietary recall with the same data obtained from the Nutrition Canada Survey. They reported good agreement between the two studies, confirming the validity of group values.

Karvetti and Knuts (19) obtained one-year diet histories, seven-day dietary records and 24-hour dietary recalls from 86 patients one-year after myocardial infarction and from 77 patients two years after myocardial infarction to compare agreement of dietary intake and changes in intake over a period of time. The diet history gave higher mean intakes for all nutrients studied. Comparison of the mean nutrient intake from the three methods showed statistically significant differences between methods. The largest difference was found between the diet history and the 24-hour dietary recall. Correlation coefficients ranged from 0.42 to 0.69 for the three methods, although, "agreement among the three methods in relation to change in nutrient intakes for this study group was poor".

The authors went on to say "As it is difficult to assess the validity of the dietary interview method, it cannot be determined which interview method has given the most reliable results."

The 24-hour dietary recall provides a good estimate of a group's mean dietary intake when compared with weighed records and with recall method such as a seven-day record or a diet history. However, researchers (6,30) have reported that the diet history gives higher mean estimates than the 24-hour dietary recall for most nutrients. Others (5,12,30,42) have failed to demonstrate agreement between the two methods. Good agreement has been reported between mean values obtained from the 24-hour dietary recall and the those obtained from weighed records (26,43,44,45). In some studies calories have been reported to be underestimated (43), overestimated (46) or to show no agreement when comparing the 24-hour dietary recall with weighed records.

Although, 24-hour dietary recall has been shown to give relatively valid mean dietary intakes for a group of individuals and is generally accepted as a reliable instrument for use in collecting data for nutritional surveys (6,7), questionable results have been found when it is used to assess dietary intake of individuals.

Stunkard et al. (48) compared observed intake with 24-hour dietary recall to study the relationship between measured and reported kilocalories. Meals for a whole day

were observed for three obese and three non-obese boys. The next day they were asked to complete a 24-hour dietary recall. The boys had no prior knowledge that they would be asked to recall their food consumption for the day before. Stunkard found a strong linear relationship between measured and reported kilocalories. The correlation coefficient was 0.96. Regression analysis showed that the boys tended to over-report food intake when it was low and under-report intake when it was high.

Todd et al. (20) investigated the validity of a 24-hour dietary recall using weighed food records of 18 healthy male theological students between the ages of 23 and 31. They concluded that the 24-hour dietary recall did not accurately estimate the results obtained from either a one-day dietary record or the mean of a 30-day dietary record for an individual. Paired-t tests did not show any consistent bias. Upon examination of the two methods, the researchers found that the subjects added meals or deleted meals, thus overestimating and underestimating quantities of both food and beverage.

Young et al. (30) reported individual values in three population groups studied. The 24-hour recall and diet histories did not give the same estimat of dietary intake and therefore, could not be used interchangeably.

Morgan et al. (6) concluded that the 24-hour dietary

recall did not adequately predict the diet as recorded by the four-day record for individuals. This was in agreement with the findings of Young et al. (30) that the 24-hour dietary recall can not be used interchangeably with the seven-day dietary record.

Balogh et al. (42) compared the 24-hour dietary recall with the diet history to investigate further the validity of the 24-hour dietary recall. The objectives of the study were to determine the optimum size of the error in relation to the number of days that data were collected and to compare the repeated 24-hour dietary recalls with a dietary history. In this way they were able to examine the relationship between foods consumed on several specific days and what subjects reported they usually ate. Balogh analyzed the dietary recalls of 71 clerical and office administrative workers participating in the Israel Ischemic Heart Disease Project. The participants were contacted one random day a month for eight or more months to obtain a 24-hour dietary recall. The results were tabulated and analyzed. Balogh first reported the coefficients of variation to demonstrate variations within individuals. This was used as a guide to the number of replications needed for estimations with a specific range of sampling error. For most nutrients two or three recalls showed less variance than when additional months were collected. They noted that the increase in variance seen as the number of

recalls increased may have reflected a seasonal variation.

Balogh reported the number of 24-hour dietary recalls required to obtain estimates of individual mean values within an approximate 20 percent margin of sampling error. To obtain total calories for ninety percent of the population nine interviews were required. Cholesterol required 45 interviews. Results were reported for 11 nutrients. The researchers concluded that a 24-hour dietary recall can accurately classify individual dietary intake when repeated measurements are made.

<u>Food frequency questionnaires</u>

The food frequency questionnaire is a dietary instrument used to obtain qualitative or semi-quantitative data on past intake which will describe an individual's or a group of individuals' usual pattern of food consumption. The method groups foods into categories and uses the frequency with which each food categories is consumed to estimate dietary patterns or nutrient intake (13). Researchers have investigated various categories for the grouping of foods since the early 1940's. Berryman and Chatfield (49) developed a list of food items grouped into 17 food categories based on a combination of criterion: (a) similar nutrient content, (b) unique contribution to the value of the diet and (c) special function in the diet. Campbell et al. (50) explored the potentials and limitations of various

food grouping schemes derived from various sources: (a) population perception of various food groups, (b) an objective scheme and (c) population use of various food groups. Other researchers have based their food group categories on HANES II data (51).

A food frequency questionnaire can have a variety of applications. It can be used to demonstrate a change in dietary practices within a population group. Axelson and Csernus (52) used a food frequency questionnaire to demonstrate a change within a young adult population group by administrating a food frequency questionnaire to obtain current intake and intake while living in the childhood home. A food frequency questionnaire can be used to demonstrate differences in dietary practices between populations. The research histories of the Neapolitan and Boston-Ireland Heart study were converted to a coded system, which recorded frequency of intake, to assess the differences in dietary practices between Italian and Irish populations (53). A food frequency questionnaire can be used to classify or rank individuals according to dietary practices or nutrient intake. Although other investigators have not found evidence to support the validity of individual dietary assessment, Willet et al. (54) found that a food frequency questionnaire could provide useful information about an individual's nutrient intake. The food

frequency questionnaire can be used to show the frequency with which specific foods or nutrients are eaten (55,56), to give baseline data for epidemiological studies or to investigate the relationships between diet and a number of chronic diseases, including coronary heart diseases, hypertension, and cancer (57,58). The food frequency questionnaire's greatest limitation is its lack of precision of the calculated nutrient intake. Asking only the frequency with which foods are consumed may overestimate or underestimate the actual intake. More recently attempt have been made to incorporate a degree of precision by developing an instrument which will give semi-quantitative data.

Although the food frequency questionnaire has recently became of great interest to researcher it is by no means a new innovation. Berryman and Chatfield (49) in the 1940's developed a method of calculating the nutritive value of diets based on quantities of food purchased or quantities of food consumed as an outgrowth of concern for improved nutritional status of the U.S. soldier. Quantities of food were reduced to a base unit of pounds per man per day. The principle of this method was much the same as other food frequency methods currently under investigation. The foods were classified into groups on the basis of this criterion, 17 food classes were identified. Then weighted nutritive values were calculated for each of the 17 classes of foods derived from data collected on frequency of foods consumed

from representative U.S. army camps. The intended use for Berryman's dietary instrument was to make a rapid assessment of the nutritional adequacy of a planned menu. Results of this assessment would determine whether or not a more extensive analysis was needed.

The validity of Berryman's instrument was investigated by application on monthly menus of three U.S. army camps. The results obtained were then compared with those calculated by the conventional method of applying average nutrient values to each average serving of each food used, then computing the grand total. A detailed comparison showed that Berryman's method was a substantially correct estimate of the longer more conventional method.

Later Heady (57) saw the need for an instrument which could be used to classify diets of large numbers of individual. An instrument which could be mailed to subjects. Heady developed a method based on assigning food "scores" to a number of key foods. From these food "scores", nutrient scores were calculated based on average serving sizes for a particular sex and age group. The total nutrient intake was calculated by multiplying the number of times food was consumed by the nutrient score. The "food scores" were derived from data collected from seven-day food records kept by 97 bank officers. The method was tested on an independent sample of 41 bank officers. Heady found that

food consumption can be reliably and validly indicated by counting frequencies, with no weighing or measuring. Heady stressed that this method was intended for use on a large homogeneous sample.

Hankin et al. (59) attempted to develop a food frequency instrument similar to Heady's. The instrument was based on four-day record obtained from a homogeneous sample, 53 Japanese-American women. Hankin's instrument was also validated against a like sample. Coefficients of determination ranged between 0.07 and 0.32. The authors concluded that there was insufficient evidence to accurately compare the four-day record with the frequency questionnaire.

Chu et al. (58) undertook a study to determine if a frequency method of collecting dietary data can substitute for quantitative methods. One hundred sixty-seven cases and 175 controls completed a food frequency form which included a list of 113 food items selected for nutrient content. If the subjects had eaten the food items listed on the food frequency form then the quantity of that item was estimated using photographic food models. The quantities estimated from food frequencies were then compared to quantitative data obtained during the interview. Three different sets of conversion factors were compiled to estimate nutrient intakes. The extent of agreement between frequency and quantitative intakes of various dietary components (44 food

items, 20 food groups, 8 nutrients) was determined at the group and individual subject levels. For food items and food groups, the level of absolute agreement between quantitative measurements and converted-frequencies was extremely low. None of the mean nutrient intakes based on the converted-frequencies and the quantitative measurements demonstrated absolute agreement.

Stefanik and Trulson (53) investigated the validity of a food frequency instrument developed to collect qualitative data. Food consumption data collected by a nutritionist directly onto a food frequency form was compared with data collected using the seven-day dietary record and a diet history interview. Comparisons were made in two ways, first based on foods consumed more frequently than once per week and second foods consumed once per week or less. The authors concluded that the food frequency form gave generally equivalent estimates of qualitative food consumption upon paired and unpaired comparisons of diet habits at both group and individual level.

Smith-Barbaro et al. (60) however, found extremely low agreement between a seven-day dietary record and a 39 food item food frequency questionnaire. To test validity subjects keep a seven-day diet record of all foods consumed after which the data obtained from three different food frequency questionnaires, (a 39 food item, a 31 food item,

and a 55 food item questionnaire) were compared. The food frequency containing 39 food items presented in order of meals consumed demonstrated closest agreement with the seven-day dietary record. Higher correlations were demonstrated when food frequency data were calculated for nutrient intake than for types of foods consumed. Ten of the 39 food items were significantly correlated. When these researchers tested the reliability of three different food frequency questionnaires, the form with the broadest food categories (31 food categories) proved to be the most reliable with 83 per cent of the food items significantly correlated.

Stuff et al. (51) found poor agreement when they compared food consumption data obtained from a seven-day dietary record with data obtained from a food frequency form. The food frequency interview required the estimation of serving sizes. Estimations were aided by the use of food models. The food frequency form was comprised of a list of 105 single foods and mixed dishes and provided the option to include foods not specifically listed. Food items for the food frequency form included all food group classification used by HANES. The mean intake for calories, protein, fat, carbohydrate, calcium, phosphorus, and iron were estimated from each of the dietary instruments used. Correlations for the two methods ranged from 0.00 to 0.24. Use of the food frequency resulted in mean values which were significantly

greater than those obtained from the seven-day dietary record ($p<0.001$) in more than half the nutrients studied.

Unlike the attempts to validate a food frequency questionnaire by comparison with a seven-day dietary record Abramson et al. (61) used a recall method obtaining information from 60 Jewish men ages 17 to 39. Food frequency data were collected during a 30 minute segment of a longer interview in which quantitative data were acquired from estimated values. The food frequency information was categorized in two ways: (a) the number of times the food was taken per week and (b) the number of days per week. Quantities of specific food items were estimated in household measures and grams or milliliters. Abramson found moderate to high correlations between the frequency data and the quantitative data. Most of the correlation coefficients were over 0.8; the range was 0.42 to 0.99. The results also showed that the number of days per week a food was consumed related less well to quantity than did number of times per week. Abramson concluded "that the variation in the size of the servings (of most foods) did not outweigh the effects of differences in frequency." The correlation between the frequency and quantity method were not in good enough agreement to use on individual dietary data, but, they were close enough to warrant use with moderately sized groups.

Richard and Roberge (62) found that a shortened method of dietary analysis based on food group frequencies and multiple regression gave similar mean values for nutrients and energy when compared with a three-day record when n=133 and, again, when n=87.

Nineteen individuals in a metabolic research unit were studied by Krall et al. (63). The subjects completed a one-week food frequency questionnaire and two three-day dietary records. By using this population, the researchers were able to measure precisely and observe unobtrusively food intake for validation studies. All eight nutrients studied were underestimated by the food frequency questionnaire ($p<0.05$). Nutrient intakes obtained by the food frequency questionnaire were underestimated from nine percent (vitamin C) to 24 percent (cholesterol) lower than actual. Vitamin A ($p<0.001$) and calories were underestimated by the three-day dietary records. Nine percent of all food items served over the six days of recording were underestimated.

Similar results were obtained by Willet et al. (40) when they attempted to validate a one-year food frequency questionnaire using the average of four one-week records. These researchers investigated the validity of a 61-item semi-quantitative food frequency questionnaire. The questionnaire was administered at the beginning and at the end of a one-year period. Data from the food frequency questionnaire were compared with four one-week diet records

collected during the period for which the food frequency questionnaire was administered. Correlation coefficients, between the mean calorie-adjusted intake from the four one-week diet records and those from the food frequency questionnaire completed after the diet records, ranged from 0.36 to 0.75.

In another study Willet et al. (54) compared one-year dietary weighed records with a self-administered semi-quantitative food frequency questionnaire which was completed 18 months after the dietary records. There were 27 men and women ages 20 to 54 in the study. Estimates of mean nutrient intake based upon the questionnaire were within ten percent of the mean nutrient intake based upon the weighed record for 11 of the 18 nutrients measured. For all but one nutrient, the difference between methods was less then 25 percent. Correlation coefficients comparing unadjusted nutrient intakes measured by the two methods ranged from 0.38 to 0.65 for the 18 nutrients measured.

Karipaa and Seppanen (64) tested the validity of a self-administered dietary questionnaire developed to gather food consumption data for the Swedish "Diet-physical Activity-Health" study. The instrument was a shortened method for obtaining 24 hour diet recall data in which the quality index of the diet was computed according to the type of food eaten and the number of times it was eaten per day.

The subjects for this study were 75 Finnish men and women over the age of 30. The Swedish questionnaire was modified to fit Finish eating habits. The frequencies obtained from the self-administered questionnaire were compared with frequencies computed from the 24 hour dietary recall. The mean frequencies were nearly identical. The authors concluded that although the 24-hour dietary recall is not considered acceptable for gathering individual food intake data it is acceptable for obtaining group values. The self-administered shortened 24-hour dietary recall may be used in place of the longer 24-hour interview method when diet is being evaluated as part of health behavior.

Caster (65) obtained 24-hour dietary recalls from 102 women and food frequencies from 249 women simultaneously. The food frequency questionnaire contained a list of 100 common foods and was adapted to this population. The estimated energy intake obtained from the food frequency questionnaires was nearly two-fold that obtained from the 24-hour dietary recalls. T-test values for the difference between means were between 3.23 and 15.56 ($p<0.01$).

Hunt et al. (66) tested the validity of a computerized food frequency questionnaire consisting of a list of 60 foods of specified portions sizes. The food frequency questionnaire was developed to obtain individual dietary data from 46 adult staff members of the School of Dentistry, at the University of California, Los Angeles. The average

nutrient intake of five successive weekly 24-hour dietary recall interviews was compared with the average nutrient intake of the food frequency questionnaires for each individual. There were small correlation coefficients and wide confidence intervals between the two methods. Protein, niacin and calorie means estimated from the two methods were within three to six percent of one another. All other nutrient intakes were between 16 and 80 percent higher when obtained from the computerized food frequency than when obtained from the five 24-hour dietary recalls.

Axelson and Csernus (52) administered a food frequency checklist to food and nutrition graduate students in order to measure change in food consumption since childhood. The food frequency instrument was designed to measure retrospective as well as present food intake. The subject's ages were between 21 and 28 years. The mean time away from home was 10.7 years. The experimental group's present food frequency data were compared with 23 to 24 year olds in the 1977-78 USDA National Food Consumption Survey (NFCS). Their childhood food intake was compared with 12 to 14 in the 1965-55 USDA NFCS. Data obtained from the food frequency checklist and from the NFCS were converted to frequency per week. Absolute differences between present and past intake were calculated. The authors demonstrated remarkable similarities in recall frequency from childhood to present.

"Changes in frequency from childhood to present was in the same direction (increase or decrease) for all food groups studied except meats and sweets."

Gray et al. (67) interviewed 50 subjects using modified diet history which contained a recall of a typical day's diet and a 83 item food frequency questionnaire representing all four food groups as the "cross-check". Intakes of vitamin A and C from the diet history were calculated using values from standard food composition tables. Three different methods were used to estimate intakes of vitamins A and C intake from the self-administered food frequency questionnaire. The first was "to add the products of the frequency of use of foods and the vitamin content of an average serving. The second was to develop an index based on the sum of frequencies of consumption of foods rich in these vitamins. This was then converted to absolute amounts using a regression equation. The third was to use stepwise multiple regression with the estimated intakes from the history as dependent variables and to develop an equation with a small number of foods as the independent variables." The highest degree of correlation occurred when the analysis included vitamin intake from dietary supplements. These correlations were between 0.35 and 0.44 for vitamin A and between 0.62 and 0.64 for vitamin C. The authors concluded that food frequency questionnaires can provide good estimates of means and median dietary intakes of vitamins A

and C compared to those obtained from a diet history. Food frequency questionnaires were less helpful in estimating the intake of individuals.

Validity of the food frequency questionnaire used in this study was examined previously (68) when dietary data were collected from 20 nutrition students using both the food frequency questionnaire and the three-day record. Correlation coefficients were computed to compare average energy and nutrient intake as measured by the three-day record with that measured by a composite day of food frequency data. Iron and phosphorus were positively correlated ($p<0.05$) while those for energy, riboflavin, and calcium were correlated at $p<0.10$. The researcher concluded the students used for this investigation exhibited atypical eating data which may leave room for error in estimations of dietary intake data. Reliability was tested with the same group of 20 nutrition students. Positive correlations ($p<0.05$) were found for energy and nine nutrients.

Researchers have found that food frequency questionnaires give fairly accurate estimations of qualitative food consumption for groups of individuals (53, 61). Better results are obtained when the food frequency questionnaire is modified to fit the dietary patterns of a homogenous population (57, 64, 51). Researchers also have found that questionnaires that contain fewer and

broader categories have proven to be more reliable(60). Conflicting results have been found by researchers when comparing food frequency data with quantitative food consumption data. Several researchers have found good agreement between seven-day and four-day dietary records compared with semi-quantitative food frequency questionnaires (40,62). Others have found extremely low agreement when comparing these two instruments (60,58,63).

Processing Dietary Intake Data

The instruments used for the collection of dietary intake data can only obtain amounts of food consumed with the exception of computerized questionnaires which allows for frequencies of food intake to be directly processed to nutrient intake. More often than not epidemiologists and nutritionists are interested in nutrient intake rather than merely the foods consumed by a population sample. As with the instruments selected for the collection of dietary data, the methods used to convert foods consumed into nutrient intakes have varying degrees of precision. The selection of a method for the processing of dietary intake data demands a clear understanding of the limitations and advantage of each method as well as a clear understanding of the information being sought by the researchers. Rapidity of results may outweigh the benefits of precisely determined nutrient intake. Or the cost of one method may justify its use for a

particular study.

Chemical Analysis

Chemical analysis is by far the most precise tool of obtaining nutrient intake. Samples to be analyzed are collected by obtaining "duplicate portions" (12) (i.e., For all foods consumed a duplicate amount or an aliquot is kept for analysis.), or an "equivalent composite" (12), (i.e., raw food samples are purchased and analyzed). With the latter, obvious problems arise in the ability to obtain foods with exact chemical composition due to large variation in nutrient content of same types of foods and with the ability to reproduce exactly the foods actually consumed. In the duplicate method the burden lies with the researcher to obtain and preserve samples of foods consumed. Chemical analysis is extremely costly, in addition to requiring special laboratory conditions, making this method impractical for many researchers and many population groups. The main usefulness of this process is in establishing the reliability of results obtained from the collection of dietary data from one of the traditional methods.

Food composition Tables

The most used tool for conversion of dietary intake to nutrient intakes is standard food composition tables based on chemical analysis of food. The most commonly used is the

US Department of Agriculture Home and Garden Bulletin No. 72, Nutritive Value of Foods (69) which are based on values from the US Department of Agriculture Handbook No. 8, Composition of Foods - Raw, Processed, and Prepared (70). These are both available on computer tape. Another commonly used food composition food table is Bowes and Church's: Food Values of Portions Commonly Used. The major limitation with the use of this method is that variety of foods available to the US consumer increases at such a rapid pace that it is impossible to have current information readily accessible. It is possible to obtain nutrient information from manufacturers and fast food restaurants. These food composition tables are culture specific. Specific food composition tables are available for various countries. These limitations far outweigh the expediency with which information is obtained. By a relatively small investment of time and money as compared with direct chemical analysis and its easy application to large population groups, food composition tables are advantageous.

METHODS

Sample selection

In fall 1986 the department of Foods and Nutrition, Kansas State University, conducted a study of 41 Kansas farm homemakers in Jackson County to assess the nutritional adequacy of their diets. To be included in the sample the participants had to own and operate a farm of between 100 and 500 acres. The names of eligible farmers were obtained from the 1983 Jackson County plat map. Names and telephone numbers were verified using the Jackson County rural directory. Margaret Hund, the Jackson County Home Economist, and Dr. Meredith F. Smith, project director, co-signed the letter (Appendix A) sent initially to the prospective subjects. Margaret Hund was available to answer questions from the Jackson County residents concerning the study.

A week after the invitation to participate was mailed, each woman was contacted by telephone. If the homemaker agreed to participate in the study an appointment was scheduled either on a Thursday or a Saturday between 9:00 a.m. and 5:00 p.m. during the first three weeks of November. Thanksgiving week was excluded because of possible changes

in dietary habits during that time. A week before the home interview two questionnaires were mailed to each homemaker, one consisting of general farm production questions, and the second, was the food frequency questionnaire.

Of the 147 eligible individuals, 31 percent (n=45) agreed to participate. Of these 45, 91 percent (n=41) completed the food frequency questionnaire and a 24-hour dietary recall in November, 80 percent (n=33) of the 41 participants completed the food frequency questionnaire in March. The sample was comprised of 40 females who completed the November food frequency, 33 of those 40 who completed the March food frequency, and one male who completed all three dietary questionnaires.

Food frequency questionnaire

A self-administered dietary questionnaire developed by John L. Stanton at St. Joseph University, Philadelphia, PA was the questionnaire used in this study (Appendix B). The food frequency questionnaire consists of fifteen food categories with a total of 93 food groups which are aggregates of specific food items. Frequencies of intake are recorded by the respondent. A computer program is used to convert the frequency with which each food group is eaten to a per day basis. The frequencies per day of each food group are multiplied by the average serving size for a specific sex and age group to obtain grams per day. The

grams eaten per day are converted to nutrient intake per day. The instrument required no more than 30 minutes to complete.

The weighted intakes, serving sizes and nutrients in grams for each food item in a food group, were derived from data obtained in the second National Health and Nutrition Examination Survey (NHANES II). A computerized nutrient analysis program expressed daily intakes as percentage of the 1980 RDAs. The NHANES II data for each of the 20,319 participants were converted to the food frequency questionnaire to investigate the validity of the instrument. The converted values were then used to predict the actual values reported by NHANES II.

The food frequency and the farm survey questionnaires were mailed to each homemaker that agreed to participate in the study approximately one week prior to the home interview. The participants were asked to complete the questionnaire before our arrival. The food frequency questionnaire included printed instructions asking the respondent to circle the number of times, each day, week, or month each food item was eaten. Foods eaten only seasonally were noted. If the respondent had questions when completing the form, they were asked to wait until the time of the home visit for clarification. During the home visit, related demographic information and the heights and weights of the homemaker were obtained by a trained interviewer. A plasic

tape measure against a door frame was used to obtain height in inches and an ordinary bathroom scale calibrated with a known weight, was used to record weight. To test the reliability of the food frequency questionnaire each individual who completed it in November was asked to complete it again in March.

Pretest

The clarity of the instructions for completing the food frequency questionnaire was tested by administering the instrument to fifteen women who were similar to the study population. The pretest was given at a meeting of the Kansas Farm Wives Association. A member of the research team administered the test and was available to answer questions about the form. The form required an average of 20 minutes to complete. The self-administered test proved to be understandable. No validation studies were performed with these sample data.

24-hour dietary recall

A 24-hour dietary recall interview along with the interview for the Jackson County farm survey, The Factors Affecting the Nutritional Adequacy of Farm Women was conducted with each homemaker by a trained interviewer during the home visits in November 1986. Food consumption for a 24-hour period prior to the interview was recalled in

as much detail as possible. Forms for recording the data are included in Appendix B. Training sessions for the interviewers were held prior to the study. A structured interview reduces the bias which might occur as a consequence of such an in-depth interview and persistence of probing by the interviewer (21) Instructions for probing were outlined. The instructions included the use of words such as type, variety, and brand. Specific reminder words such as broiled, fried, poached were used to inquire about food preparation techniques of a particular item. Interviewers were trained not to suggest answers. Care was taken not to refer to specific meals, that is breakfast, lunch, etc., but instead to ask "What was the first thing you ate or drank when you arose yesterday morning?" This way the respondent was not forced into a three meal-a-day pattern. The respondents were asked the kinds and amounts of food eaten the day before our visit, beginning with the first item they ate in the morning to the last item they ate before they went to bed.

The respondent was helped to estimate portion size by a dietary kit containing simulated food portions models (1/4, 1/2, and 1/3 cup portion of dried beans and rice) which could be displayed on dinner plates and other common tableware to represent a range of alternative portion sizes. Various sized drinking glasses were marked in 2,4,6, and 8

ounce levels to aid in judging liquid portion sizes. A variety of spoons were included representing a range of measurements. Cardboard rectangles and circles were marked in various portion sizes as aides. The respondents' estimations of food portions were given in common household measurements and recorded.

Special attention was given to methods of food preparation in order to obtain quantitative information regarding mixed dishes. The components of mixed dishes were listed singly or recipes were obtained. The respondents were then asked to estimate what portion of the mixed dish they had eaten.

Energy and intakes of selected nutrients were calculated by computer using the Department of Foods and Nutrition's data base, which combines the United States Department of Agriculture (USDA) Data Tape of Handbook 8 (70), and Home and Garden Bulletin 72 (69). A computerized evaluation of the 24-hour dietary recall, which included the participants' energy and nutrient values and a comparison with the Recommended Dietary Allowances for their age and sex, was mailed to each participant who completed the interview.

ESULTS AND DISCUSSION

Mean intakes of energy and eight nutrients (protein, vitamin A, ascorbic acid, thiamin, riboflavin, niacin, calcium, and iron) were obtained from three sources: the food frequency questionnaire and the 24-hour dietary recall both administered in November 1986 and the food frequency questionnaire in March 1987.

Validity

Analysis of variance

To test the validity of the food frequency questionnaire, analysis of variance was computed for the mean nutrient intakes obtained from the November food frequency questionnaire and the 24-hour dietary recall. The analysis of variance showed no difference ($p<0.05$) for the mean intakes of vitamin A, calcium, and iron between the two instruments. The mean intakes of energy, protein, ascorbic acid, thiamin, riboflavin, and niacin obtained from the November food frequency were significantly higher than mean intakes obtained from the 24-hour recall (Table 1). Previous researchers have found that mean nutrient intakes estimated from a food frequency questionnaire were higher than those obtained from a 24-hour dietary dietary recall (65,66).

Table 1. Energy and nutrient intake data obtained from a food frequency questionnaire and a 24-hour dietary recall administered in November.

	Food Frequency (N = 41)		24-hour recall (N = 41)		
	means ±	S.D.	means ±	S.D.	P-Value
energy,kcal	2319.0	904.0	1460.0	457.0	.0001
protein,gm	94.9	42.0	60.9	23.5	.0001
vitamin A,IU	8401.0	3581.0	5752.0	8448.0	.0624
ascorbic acid,mg	171.1	146.3	108.3	89.1	.0108
thiamin,mg	1.68	0.78	1.08	0.47	.0001
riboflavin,mg	2.44	1.27	1.43	0.72	.0001
niacin,mg	23.8	9.4	16.5	7.3	.0004
calcium,mg	1101.0	607.0	642.0	387.0	.1067
iron,mg	17.3	6.6	11.2	5.8	.4204

Numerous researchers (6,19,27,28,29,31,32,51,59,) have found that diet histories, used to estimate retrospective dietary intake, demonstrated higher mean intakes than dietary records or 24-hour dietary recalls, used to estimate current dietary intake. From this we might then expect that a food frequency questionnaire, which is used to gather retrospective dietary intake data, would report higher mean values than a 24-hour dietary recall. The magnitude of differences between the mean values obtained from these two

instruments may have been further accentuated by the tendency of the 24-hour dietary recall to overestimate small intakes and underestimate large intakes (16,17,18). The 24-hour dietary recall estimated a mean energy intake less than 100 percent of the RDA (Appendix D). Therefore, our sample may have consumed small portions which were overestimated. If this is true, then the actual difference in energy intake as measured by the two instruments may be even greater than reported.

Correlations

Correlation coefficients were computed for the mean daily nutrient and energy intakes obtained from the November food frequency and the 24-hour dietary recall (Table 2).

Table 2. Correlation coefficient between energy and nutrient intakes obtained from a food frequency and 24-hour dietary recall data.

	(N=41) correlation coefficient	P-values
energy, kcal	0.26	0.10
protein, gm	0.09	0.59
vitamin A, IU	0.10	0.54
ascorbic acid, mg	0.26	0.10
thiamin, mg	0.03	0.85
riboflavin, mg	0.10	0.52
niacin, mg	- 0.01	0.94
calcium, mg	0.22	0.17
iron, mg	0.03	0.84

No statistically significant correlations were found between the estimated intakes obtained by the November food frequency questionnaire and the 24-hour dietary recall. Other researchers (51,58,60,63,65,66) have found that nutrient intakes estimated from a food frequency instrument did not correlate well when compared with other dietary instruments used to gather quantitative data. Abramson et al (61) found good agreement between the food frequency instrument and a seven-day dietary record. However, in that

study, the food frequency instrument had been modifed to obtain quantitative data. Karipaa and Seppanen (64) found good agreement between qualitative information obtained from the food frequency instrument and qualitative information obtained from a 24-hour dietary recall.

The associations found between the nutrient estimations obtained from the food frequency questionnaire and from a 24-hour dietary recall (64) or a seven-day food record (57) were stronger when the food frequency questionnaire had been developed for a specific population than when the questionnaire has not been targeted for a specific population (51,60,65,66). The food frequency questionnaire used in this study was based on data obtained from NHANES II, and therefore was not specifically developed for our population.

These results demonstrate that the validity of the food frequency questionnaire was not determined when compared with a 24-hour dietary recall. If the 24-hour dietary recall obtained high (or low) values for a specific nutrient, these were not consistant with values obtained from the food frequency questionnaire. Therefore the validity of this food frequency instrument was not established for use with rural homemakers.

Reliability

<u>Analysis of variance</u>

Reliability was assessed by computing analysis of variance and correlation coefficients between the mean daily energy and nutrient intakes obtained from the food frequency questionnaire administered in November 1986 and March 1987.

Table 3. Energy and nutrient intake data obtained from a food frequency questionnaire administered in November and in March.

	Food Frequency November (N = 41)		Food Frequency March (N = 33)		
	means	S.D.	means	S.D.	P-Value
energy,kcal	2319.0	904.0	2057.0	719.0	.0168
protein,gm	94.9	42.0	79.0	27.8	.0264
vitamin A,IU	8401.0	3581.0	7119.0	2333.0	.0572
ascorbic acid,mg	171.1	146.3	165.0	64.8	.5767
thiamin,mg	1.68	0.78	1.48	0.43	.0677
riboflavin,mg	2.44	1.27	1.91	0.70	.0057
niacin,mg	23.8	9.4	20.6	5.7	.0224
calcium,mg	1101.0	607.0	849.0	369.0	.0120
iron,mg	17.3	6.6	15.5	4.24	.0549

There were no significant differences in intakes of vitamin A, ascorbic acid, thiamin, and iron (Table 3). Statistical differences were found between energy,

protein, riboflavin, niacin, and calcium. Marr et al. (15) addressed the question of seasonality for individual food consumption gathering evidence that demonstrated seasonality should not be overlooked. Our data were collected in November and again in late February and early March, all winter months. We did not expect to see a change in dietary intake because of seasonal changes. Vitamin A and ascorbic acid are nutrients supplied by seasonal fruits and vegetables and are thus the nutrient mostly likely to be affected by seasonal changes. Our analysis of variance demonstrated that these two nutrients did not change significantly from one administration of the food frequency questionnaire to the next for the group of individuals studied. The stability of the results obtained for these two nutrients gives evidence that seasonality had no effect on the nutrient intake of the group of individuals studied.

Correlations

Correlation coefficients were computed for the November and the March food frequency questionnaire estimating the mean daily intake of energy and selected nutrients (Table 4).

Table 4. Correlation coefficients between mean nutrient intakes obtained from a food frequency questinnaire in November and in March.

	(N = 41) correlation coefficient	P-values
energy, kcal	0.75	0.0001
protein, gm	0.58	0.0004
vitamin A, IU	0.21	0.24
ascorbic acid, mg	-0.29	0.10
thiamin, mg	0.51	0.0024
riboflavin, mg	0.62	0.0001
niacin, mg	0.52	0.0017
calcium, mg	0.56	0.0007
iron, mg	0.55	0.0009

The correlation coefficients showed good agreement for all nutrients with the exception of vitamin A (0.21, P=0.24) and ascorbic acid (-0.29, p=0.10). Correlation coefficients ranged from 0.75 ($p<0.0001$) to 0.51 ($p<.002$) for energy and six of the eight nutrients studied. Dawber et al (34) and Young (37) considered correlation coefficients of 0.5 to 0.8 for the sequential estimates of dietary factors to be satisfactory. Tremblay et al (22) found retinol to show no significant correlations ($r=-0.06$) when three-day records were administered seven days apart. Several researchers (19,60) have found vitamin A and ascorbic acid to be the most variable nutrient in an individuals diet. If this is

true, correlation coefficients could show poor agreement when data are collected for a short time period. The positive correlations demonstrated that from repeated administration of the food frequency questionnaire, variations in nutrient intake for this sample of individuals can accurately be assessed using this instrument. Axelson and Csernus (52) found a food frequency instrument to be very useful in assessing changes in dietary habits of individuals from childhood to adulthood.

Based on the results obtained from a single study it would be premature to conclude that the food frequency questionnaire under investigation was not a valid and reliable instrument. Although the interviewers were instructed on specific interviewing techniques none had good familiarity with the coding manual. Such familiarity may have given the interviewer insight as to what details would need to be emphasized during the interviews. Also, all coding was done by the same individual, no cross-check was done.

If one is seeking information to assess the nutritional adequacy of the food habits of a specific population group modification to the food frequency questionnaire may result in more accurate information. The food frequency questionnaire under study could be modified to assess the specific food practices of Kansas farm families (57,64). Modifications to obtain data regarding intake of specific

nutrients also could be useful (67).

We have found evidence to demonstrate that the food frequency questionnaire under investigation is a reliable instrument. That is, similar results will be obtained upon repeated administration of this instrument. An instrument that has proven to be reliable can be used to demonstrate changes in dietary practices within a population group. This information would be helpful when trying to determine whether or not some variable now present but not present previously influenced the food consumption habit of a target population. Such an instrument also could be used to demonstrate a difference in food consumption habits between groups of individuals. For example, do individuals who consume a certain food have a higher incidence of a particular disease verses a group who does not consume that food? This food frequency questionnaire also may be used to assess patterns of usual intake for a group of individual.

SUMMARY

The mean daily energy and nutrient intakes of forty-one subjects was estimated from a food frequency questionnaire and compared with those intakes estimated from a 24-hour dietary recall from the same subjects. Although the two instruments produced similar ($p<0.05$) mean estimates of vitamin A, calcium, and iron intakes, data on energy and five of the eight nutrients studied were not in good agreement. The food frequency questionnaire estimated significantly higher mean intakes for energy and all nutrients studied when compared with the 24-hour dietary recall. No statistically significant correlation was found between the food frequency questionnaire and the 24-hour dietary recall for energy and the eight nutrients studied. In conclusion we found that the two instruments when administered to a group of rural homemakers did not give similar mean estimates of energy and selected nutrients.

The mean daily nutrient and energy intakes were estimated for 41 subject in November using the food frequency questionnaire, and again in March for 33 of the 44 subjects. To test reliability of the instruments comparisons were made between the data collected during the two time periods. There were no significant differences in vitamin

A, ascorbic acid, thiamin, and iron intakes. Energy and all other nutrients showed significant differences. Correlation coefficients ranged from 0.75 ($p<0.0001$) to 0.51 ($p<0.002$) for energy and six of the eight nutrients studied when a food frequency questionnaire was administered four months apart. Vitamin A and ascorbic acid were the only exceptions showing relatively low correlations. In conclusion we have found the food frequency questionnaire under investigation was a reliable instrument to administer to a group of rural homemakers when assessing changes in nutrient intakes.

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APPENDICES

APPENDIX A

Subject correspondence

October 16, 1986

&TITLE& &FNAME& &LNAME&
&STREET&
&CITY&

Dear &TITLE& &LNAME&:

Graduate students in the Department of Foods and Nutrition at Kansas State University are studying the food habits of Kansas farm families. They will be calling you in the near future to ask your cooperation. If you agree to participate in the study you will be mailed a questionnaire about the foods you produce, preserve, and eat. The students will make an appointment to pick up the questionnaire. They will also want to re-interview you in early spring.

All information on the questionnaire will remain confidential. The questions will be about food, not finances or economic conditions. If you complete the questionnaire we will do a nutritional analysis of your diet. This will tell you how much protein, fat, starch, vitamins and minerals you need and how much you are getting in the foods you eat. You can use this information to change the foods you eat. At the same time you will help us collect information that will enable us to develop better programs for Kansas farm families.

We hope you will be willing to cooperate. If you have any questions, please call or write either of us.

Sincerely yours,

Margaret Hund
Home Economist
Holton County
364-4125

Meredith Smith, Ph.D.
Associate Professor
Department of Foods & Nutrition
913-532-5508

APPENDIX B

Food frequency questionnaire

FOOD INTAKE QUESTIONNAIRE

We would like for you to answer this food intake questionnaire designed to help you learn more about the way you eat. It will take about twenty minutes to answer all of the questions. After you answer all of the questions, you'll receive an analysis of your diet. This same analysis would cost a great deal of money if it was conducted by a nutritionist.

Name____ Date_______________________________

I. GENERAL INFORMATION

1. How old are you? ________
2. Are you male or female? [ ] male [ ] female
   If female, are you pregnant? [ ] or breast feeding [ ]
3. In your usual day, how active are you?
   a. heavy physical work most of the day ______
   b. occasional heavy physical and light work most of the day _____
   c. I am not very active _____
4. What is your general state of health? [ ] excellent [ ] good [ ] poor
5. Do you have any health condition that has affected your farming or food production activities during the past 6 months? [ ] yes [ ] no
6. Do you take a vitamin or mineral pill? [ ] no [ ] yes, irregularly [ ] yes, regularly

7. How many years of school have you completed? __________
8. How many years of home economics education does this include?
   _____ high school
   _____ college or university
9. How many years of agricultural education does this include?
   __________high school/FFA
   __________college or university
10. How many years of other home economics/agricultural activities have you had?
    __________4-H
    __________extension
    __________other, please specify______________________________________

11. Have you worked off farm during the past 6 months? yes _____ no _____
12. If yes, how long have you worked off-farm? ___________months
13. How many days do you work full-time? _____________per week
14. How many days do you work part-time? _____________per week _____________ hours per day
15. How much time does it take to get to your job? __________hours __________minutes
16. Has your husband (wife) also worked off the farm during the past 6 months? yes _____ no _____
17. If yes, how long have you worked off-farm? ___________months
18. How many days do you work full-time? _____________per week
19. How many days do you work part-time? _____________per week _____________ hours per day
20. How much time does it take to get to your job? __________hours __________minutes
21. If you or your husband (wife) started a job off-farm during the past 2-3 years, what were your reasons for doing so? Please check all of the primary reasons (most important) and the secondary reason(s) that apply:

Primary reason woman	Primary reason man	Secondary reason woman	Secondary reason man	
______	______	______	______	Means to remain on the farm
______	______	______	______	Income to expand the farming operation
______	______	______	______	Help pay off farm debts
______	______	______	______	Good paying job opportunity
______	______	______	______	Education for the farm children
______	______	______	______	Home improvements or remodeling
______	______	______	______	Family vacations, new clothing, medical and dental expenses, etc.
______	______	______	______	Provide retirement income
______	______	______	______	Use excess labor not used in the farming operation
______	______	______	______	Provide income and acquire off-farm job experience in order to leave farming
____________		____________		Other (please specify)________________________________

II. HOW OFTEN DO YOU EAT OR DRINK THE FOLLOWING FOODS?

Please tell us how often you ate the foods listed below during the past month.
To answer each question:
a) Circle the number that tells how often you ate the food.
b) Circle the letter that tells if you ate the food every day, week, month or year.
For example: If you drank skim milk for breakfast and before going to bed almost every day, circle 2 (for number of times) and D (for the time period). If you never drink skim milk circle 0.
If you only eat the food when it is in season circle the y.

1. MILK OR MILK DRINKS?
   (including hot chocolate, milk shakes, chocolate milk drinks)

	Never	Number of times									Per Time Period			
Skim Milk or skim milk drinks (including reconstituted dry milk)	0	1	2	3	4	5	6	7	8	9	D	W	M	Y
low-fat or low-fat milk drinks	0	1	2	3	4	5	6	7	8	9	D	W	M	Y
whole milk or whole milk drinks	0	1	2	3	4	5	6	7	8	9	D	W	M	Y

2. CHEESE OR COTTAGE CHEESE

	Never	Number of times									Per Time Period			
cottage cheese or ricotta cheese	0	1	2	3	4	5	6	7	8	9	D	W	M	Y
other cheeses such as American, Swiss, Cheddar, or Mozzarrella	0	1	2	3	4	5	6	7	8	9	D	W	M	Y
3. OTHER DAIRY PRODUCTS														
Yogurt	0	1	2	3	4	5	6	7	8	9	D	W	M	Y
Pudding	0	1	2	3	4	5	6	7	8	9	D	W	M	Y
Ice Cream	0	1	2	3	4	5	6	7	8	9	D	W	M	Y
Sour Cream or Cream Cheese	0	1	2	3	4	5	6	7	8	9	D	W	M	Y
Butter or Margarine	0	1	2	3	4	5	6	7	8	9	D	W	M	Y
Eggs	0	1	2	3	4	5	6	7	8	9	D	W	M	Y
4. MEAT														
Hamburger	0	1	2	3	4	5	6	7	8	9	D	W	M	Y
Hot dogs or Sausage	0	1	2	3	4	5	6	7	8	9	D	W	M	Y
Luncheon meats (bologna, salami, or chicken/turkey roll)	0	1	2	3	4	5	6	7	8	9	D	W	M	Y
Beef or steak	0	1	2	3	4	5	6	7	8	9	D	W	M	Y
Pork or ham	0	1	2	3	4	5	6	7	8	9	D	W	M	Y
Bacon	0	1	2	3	4	5	6	7	8	9	D	W	M	Y
Liver	0	1	2	3	4	5	6	7	8	9	D	W	M	Y
Other meats (veal, lamb, or venison)	0	1	2	3	4	5	6	7	8	9	D	W	M	Y
5. POULTRY (chicken, turkey, or duck)														
Fried poultry	0	1	2	3	4	5	6	7	8	9	D	W	M	Y
Baked or broiled poultry	0	1	2	3	4	5	6	7	8	9	D	W	M	Y
6. FISH (other than shellfish)														
Canned fish (tuna, salmon, or sardines)	0	1	2	3	4	5	6	7	8	9	D	W	M	Y
Fried fish	0	1	2	3	4	5	6	7	8	9	D	W	M	Y
Baked, broiled, or cooked fish	0	1	2	3	4	5	6	7	8	9	D	W	M	Y
7. SHELLFISH (shrimp, crab, or oysters)														
Raw shellfish	0	1	2	3	4	5	6	7	8	9	D	W	M	Y
Fried shellfish	0	1	2	3	4	5	6	7	8	9	D	W	M	Y
Baked, broiled, or cooked shellfish	0	1	2	3	4	5	6	7	8	9	D	W	M	Y
8. CEREALS, BREADS OR PASTA														
Cooked breakfast cereals	0	1	2	3	4	5	6	7	8	9	D	W	M	Y
Ready-to-eat breakfast cereals	0	1	2	3	4	5	6	7	8	9	D	W	M	Y

	Never	Number of times									Per Time Period			
Waffles (waffles, pancakes, or french toast)	0	1	2	3	4	5	6	7	8	9	D	W	M	Y
Breads, rolls, muffins, and biscuits white or whole grain	0	1	2	3	4	5	6	7	8	9	D	W	M	Y
Other Starches—Rice, potatoes or pasta														
Rice	0	1	2	3	4	5	6	7	8	9	D	W	M	Y
Pasta, macaroni, noodles or tortilla	0	1	2	3	4	5	6	7	8	9	D	W	M	Y
Fried potatoes	.0	1	2	3	4	5	6	7	8	9	D	W	M	Y
Boiled or baked potatoes	0	1	2	3	4	5	6	7	8	9	D	W	M	Y
9. <u>VEGETABLES</u> (canned, fresh or frozen, including juices)														
Yams or sweet potatoes	0	1	2	3	4	5	6	7	8	9	D	W	M	Y
Corn	0	1	2	3	4	5	6	7	8	9	D	W	M	Y
Brussel sprouts or cabbage	0	1	2	3	4	5	6	7	8	9	D	W	M	Y
Squash, zucchini, or eggplant	0	1	2	3	4	5	6	7	8	9	D	W	M	Y
Cauliflower	0	1	2	3	4	5	6	7	8	9	D	W	M	Y
Broccoli	0	1	2	3	4	5	6	7	8	9	D	W	M	Y
Carrots	0	1	2	3	4	5	6	7	8	9	D	W	M	Y
Tomatoes	0	1	2	3	4	5	6	7	8	9	D	W	M	Y
Olives	0	1	2	3	4	5	6	7	8	9	D	W	M	Y
Lettuce	0	1	2	3	4	5	6	7	8	9	D	W	M	Y
Spinach or other greens	0	1	2	3	4	5	6	7	8	9	D	W	M	Y
Green peas	0	1	2	3	4	5	6	7	8	9	D	W	M	Y
Green or yellow beans	0	1	2	3	4	5	6	7	8	9	D	W	M	Y
Dry Beans, peas, or lentils	0	1	2	3	4	5	6	7	8	9	D	W	M	Y
Soybeans or soybean products such as tofu or textured vegetable protein	0	1	2	3	4	5	5	7	8	9	D	W	M	Y
Other vegetables such as mushrooms, peppers, turnips, or beets	0	1	2	3	4	5	6	7	8	9	D	W	M	Y
10. <u>FRUIT</u> (fresh, frozen or canned but not juice)														
Citrus fruits	0	1	2	3	4	5	6	7	8	9	D	W	M	Y
Apples or pears	0	1	2	3	4	5	6	7	8	9	D	W	M	Y
Peaches or plums	0	1	2	3	4	5	6	7	8	9	D	W	M	Y
Cherries or Berries	0	1	2	3	4	5	6	7	8	9	D	W	M	Y
Bananas	0	1	2	3	4	5	6	7	8	9	D	W	M	Y
Melons	0	1	2	3	4	5	6	7	8	9	D	W	M	Y
Raisins or other dried fruit	0	1	2	3	4	5	6	7	8	9	D	W	M	Y

	Never	Number of times									Per Time Period			
Mixed fruits or other fruits (such as fruit cocktail, grapes, pineapple, or nectarines)	0	1	2	3	4	5	6	7	8	9	D	W	M	Y
11. Miscellaneous Foods														
Peanut butter	0	1	2	3	4	5	6	7	8	9	D	W	M	Y
Jams and jellies	0	1	2	3	4	5	6	7	8	9	D	W	M	Y
Pancake syrup	0	1	2	3	4	5	6	7	8	9	D	W	M	Y
Sugar or honey added to food	0	1	2	3	4	5	6	7	8	9	D	W	M	Y
Pizza	0	1	2	3	4	5	6	7	8	9	D	W	M	Y
Soups such as broth, consume, or boullion	0	1	2	3	4	5	6	7	8	9	D	W	M	Y
Other soups	0	1	2	3	4	5	6	7	8	9	D	W	M	Y
Meat gravies	0	1	2	3	4	5	6	7	8	9	D	W	M	Y
White or cheese sauces	0	1	2	3	4	5	6	7	8	9	D	W	M	Y
Tomato sauce or Ketchup	0	1	2	3	4	5	6	7	8	9	D	W	M	Y
Mayonnaise	0	1	2	3	4	5	6	7	8	9	D	W	M	Y
Low-cal salad dressing	0	1	2	3	4	5	6	7	8	9	D	W	M	Y
Regular salad dressing	0	1	2	3	4	5	6	7	8	9	D	W	M	Y
Mustard - condiments	0	1	2	3	4	5	6	7	8	9	D	W	M	Y
12. NUTS AND SNACKS														
Nuts	0	1	2	3	4	5	6	7	8	9	D	W	M	Y
Crackers	0	1	2	3	4	5	6	7	8	9	D	W	M	Y
Potato chips or corn chips	0	1	2	3	4	5	6	7	8	9	D	W	M	Y
Other snacks such as popcorn or pretzels	0	1	2	3	4	5	6	7	8	9	D	W	M	Y
13. CANDIES OR SWEET DESSERTS														
candies	0	1	2	3	4	5	6	7	8	9	D	W	M	Y
Other sweets such as cookies, cakes, pies, donuts, danish, or pastries	0	1	2	3	4	5	6	7	8	9	D	W	M	Y
cake icing	0	1	2	3	4	5	6	7	8	9	D	W	M	Y
chocolate syrup	0	1	2	3	4	5	6	7	8	9	D	W	M	Y
sherbert	0	1	2	3	4	5	6	7	8	9	D	W	M	Y
14. NON-ALCOHOLIC BEVERAGES														
Fruit or vegetable juices	0	1	2	3	4	5	6	7	8	9	D	W	M	Y
Fruit drinks (such as lemonade or Hawaiian Punch)	0	1	2	3	4	5	6	7	8	9	D	W	M	Y
Low-cal carbonated soft drinks	0	1	2	3	4	5	6	7	8	9	D	W	M	Y
Regular carbonated soft drinks	0	1	2	3	4	5	6	7	8	9	D	W	M	Y
Beverage mixes	0	1	2	3	4	5	6	7	8	9	D	W	M	Y

	Never	Number of times									Per Time Period			
Coffee or tea	0	1	2	3	4	5	6	7	8	9	D	W	M	Y
instant coffee or tea with sweetner	0	1	2	3	4	5	6	7	8	9	D	W	M	Y
coffee or tea with sugar added	0	1	2	3	4	5	6	7	8	9	D	W	M	Y

Do you usually add:
non-dairy creamers [ ] yes [ ] no
milk or cream [ ] yes [ ] no

15. ALCOHOLIC BEVERAGES

	Never	Number of times									Per Time Period			
Beer	0	1	2	3	4	5	6	7	8	9	D	W	M	Y
Wine	0	1	2	3	4	5	6	7	8	9	D	W	M	Y
Liquor or liqueur	0	1	2	3	4	5	6	7	8	9	D	W	M	Y

APPENDIX C

24-hour dietary recall form

ID NUMBER______________

Is this the way you usually eat? Yes_____ No_____

DATE OF RECALL__________

FOOD CODE	AMT. CODE	MEAL CODE	WHERE CODE	MEAL	WHERE	FOOD/TYPE/PREPARATION	AMOUNT

TAKEN BY

APPENDIX D

Percentages of the 1980 Recommended Dietary Allowances

The Recommended Dietary Allowances[a] for Females 23 to 75 years of age and Males 50 to 75 years of age.

Nutrients	Females 23-50 yrs	Females 50-75 yrs	Males 50-74 yrs
energy, kcal	2000	1800	2400
protein, gm	44	44	56
vitamin A, IU	4000	4000	5000
ascorbic Acid, mg	60	60	60
thiamin, mg	1.0	1.0	1.2
riboflavin, mg	1.2	1.2	1.4
niacin, NE	13	13	16
calcium, mg	800	800	800
iron, mg	18	10	10

[a] Food and Nutrition Board: Recommended Dietary Allowances. 9th rev. ed., National Academy of Sciences, Washington, D.C., 1980.

APPENDIX E

Individual dietary intakes and percentages of the 1980 RDAs

for Jackson County homemakers from a

November food frequency questionnaire, (n=41)

a November 24-hour dietary recall, (n=41),

and a March food frequency questionnaire, (n=33)

OBS	ID	KCAL1	PROT1	VITA1	ASCOR1	THIAM1	RIBO1	NIACIN1	CALCIUM1	PHOS1	IRON1	KCALR1	PROTR1	VITAR1	ASCORR1	THIAMR1	RIBOR1	SPI1	NIACINR1
1	1	1231.66	60.04	5538.9	59.55	0.74	1.44	16.80	822.52	979.62	10.40	61.0	136.4	133.4	99.2	74.6	120.3	0	129.2
2	2	1500.78	63.21	6753.3	100.05	1.05	1.99	18.82	1032.01	1347.37	13.97	64.1	143.6	168.8	106.7	105.1	166.4	.	144.7
3	4	2896.40	114.87	12052.3	169.09	2.07	2.80	28.26	1148.01	1832.27	21.52	123.7	261.0	301.3	261.6	207.8	233.8	.	217.4
4	5	1850.59	88.24	12971.8	191.31	1.45	2.22	21.97	749.50	1380.45	18.17	91.7	200.5	324.2	318.8	145.2	185.3	.	169.0
5	7	2755.25	85.99	8309.3	186.29	1.62	2.18	19.29	1051.10	1742.35	16.35	117.7	195.4	207.7	310.4	162.2	182.3	.	148.4
6	8	1682.38	61.67	6027.8	137.36	1.20	1.46	18.03	711.29	1076.98	12.44	71.8	140.1	150.6	228.9	120.7	121.9	.	138.6
7	9	1701.10	63.42	7440.8	216.23	1.19	1.65	16.17	728.63	1019.96	12.67	72.6	144.1	186.0	360.3	119.3	137.8	.	124.4
8	10	1481.82	54.73	5083.1	103.90	0.94	1.27	16.63	471.94	869.05	12.48	63.3	124.3	127.0	173.1	94.1	105.9	.	127.9
9	11	2949.24	67.75	7763.7	383.46	2.21	1.56	30.16	484.08	1212.96	22.27	126.0	153.9	194.0	639.1	221.4	130.0	.	232.0

OBS	CALCIMR1	PHOSR1	IRONR1	FAT1	CARBO1	SODIUM1	POTAS1	SATUR1	CHOLE1	CARBPER1	FATPER1	PROTPER1	KCAL2	PROT2	VITA2	ASCOR2	THIAM2
1	77.8	122.4	104.0	56.70	117.17	2277.43	2467.93	22.35	241.86	38.1	41.4	19.5	.	.	.	.	.
2	129.0	168.4	139.7	58.72	174.83	1704.72	3426.26	22.42	729.73	46.6	35.2	16.8	1413.52	40.77	6227.8	182.56	1.24
3	143.5	229.0	215.2	143.80	290.19	6023.97	3378.94	52.13	643.56	40.1	44.7	15.9	2409.86	89.08	9995.2	213.82	1.89
4	93.6	172.5	181.7	79.50	200.83	3763.55	3048.13	28.95	617.80	43.4	38.7	19.1	1528.76	84.02	7506.6	179.76	1.19
5	131.3	217.7	163.5	124.24	333.26	4154.48	3169.63	44.02	342.70	48.4	40.6	12.5	2716.87	78.65	5469.6	197.82	1.67
6	88.9	134.6	69.1	72.31	196.74	3274.10	2822.06	25.71	259.69	46.8	38.7	14.7	1854.79	77.58	4730.0	179.98	1.39
7	91.0	127.4	126.6	71.87	207.23	2518.02	2469.43	26.63	268.30	48.7	38.0	14.9	1686.14	67.46	9622.9	183.44	1.38
8	58.9	108.7	124.8	59.56	184.29	2186.55	2316.01	21.53	181.84	49.7	36.2	14.8	1472.31	59.39	4408.3	109.73	1.04
9	60.7	151.6	222.7	106.79	445.42	3525.19	5504.73	30.24	223.83	60.4	32.6	9.2	1130.23	36.04	9218.3	154.64	1.12

OBS	RIBO2	NIACIN2	CALCIUM2	PHOS2	IRON2	KCALR2	PROTR2	VITAR2	ASCORR2	THIAMR2	RIBOR2	SPI2	NIACINR2	CALCIMR2	PHOSR2	IRONR2	FAT2	CARBO2	SODIUM2
1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
2	1.69	12.71	687.41	885.38	11.65	70.1	92.6	155.6	304.2	124.3	141.5	.	97.7	85.9	110.6	116.5	47.99	209.50	1776.82
3	2.00	26.08	680.23	1397.39	18.40	102.9	202.4	249.8	531.3	188.9	166.8	.	200.6	85.0	174.6	183.9	102.27	282.18	3849.04
4	1.69	18.66	623.75	1161.47	12.52	75.8	190.9	187.6	299.6	119.1	141.4	.	143.5	77.9	145.1	125.2	67.52	149.89	2357.02
5	1.87	18.21	938.49	1402.19	14.74	116.1	178.7	136.7	329.7	167.7	155.8	.	140.1	117.3	175.2	147.4	108.30	365.56	4502.49
6	1.65	17.36	844.85	1251.23	14.09	79.2	176.3	118.2	299.9	139.1	138.1	.	133.5	105.6	156.4	78.2	82.34	202.68	3608.36
7	2.30	18.10	1078.33	1279.60	13.50	72.0	153.3	240.5	305.7	138.6	191.7	.	139.2	134.7	159.9	135.0	68.23	205.98	3001.23
8	1.45	17.75	584.18	986.02	12.52	62.9	134.9	110.2	182.8	104.2	121.4	.	136.5	73.0	123.2	125.2	58.53	176.85	2326.73
9	1.32	13.68	560.08	711.18	10.71	48.3	81.9	230.4	257.7	112.6	110.0	.	105.2	70.0	88.8	107.1	36.08	173.24	1676.40

OBS	POTAS2	SATUR2	CHOLE2	CARBPER2	FATPER2	PROTPER2	KCAL3	PROT3	VITA3	ASCOR3	THIAM3	RIBO3	NIACIN3	CALCIUM3	PHOS3	IRON3	KCALR3	PROTR3
1	.	.	.	.	.	.	111.72	4.33	200.6	2.73	0.11	0.27	1.23	71.13	80.13	1.09	4.7	9.8
2	2082.35	16.05	384.20	59.3	30.6	11.5	1016.70	29.29	3073.6	161.95	1.15	1.40	17.56	493.16	756.11	11.07	43.4	66.4
3	3120.80	35.53	412.37	48.5	38.2	14.8	1190.56	44.71	1191.8	61.32	0.73	0.94	7.80	625.70	758.24	7.84	50.8	101.6
4	2458.02	26.03	505.17	39.2	39.7	22.0	1138.98	48.57	4662.9	73.21	0.83	1.34	10.97	627.86	813.83	16.56	56.4	110.3
5	3373.27	39.57	342.01	53.8	35.9	11.6	1193.20	55.97	1264.3	158.23	0.88	1.09	19.05	642.39	955.25	7.06	50.9	127.2
6	2667.21	29.34	340.93	43.7	39.9	16.7	2253.69	125.01	2467.0	133.76	1.33	2.08	25.21	1039.91	1796.55	16.97	96.3	284.1
7	2767.26	25.40	235.55	48.9	36.4	16.0	1299.73	58.92	6754.4	268.33	1.24	1.62	15.57	890.08	948.38	10.69	55.5	133.9
8	2167.48	19.63	319.52	48.0	35.8	16.1	1411.89	68.14	21619.2	48.87	1.27	1.28	14.52	667.63	1198.03	6.11	60.3	154.8
9	2133.65	11.78	113.78	61.3	28.7	12.8	1606.18	52.66	48521.4	271.13	1.74	2.25	22.38	481.35	906.41	20.20	68.6	119.6

OBS	VITAR3	ASCORR3	THIAMR3	RIBOR3	SPI3	NIACINR3	CALCIMR3	PHOSR3	IRUNR3	FAT3	CARBO3	SOOIUM3	PUTAS3	SATUR3	CHOLE3	CARBPER3	FATPER3	PROTPER3
1	5.0	4.5	11.8	22.9	.	9.4	8.8	10.0	10.9	3.24	16.15	299.54	213.99	1.10	8.21	57.8	26.1	15.5
2	76.8	269.9	115.0	116.6	.	135.0	61.6	94.5	110.7	31.85	167.04	709.32	2873.47	9.38	287.54	65.7	28.2	11.5
3	29.7	102.2	73.5	78.7	.	60.0	78.2	94.7	78.3	56.66	131.83	2942.22	1665.60	21.21	373.48	44.3	42.8	15.0
4	116.5	122.0	84.0	111.7	.	84.4	78.4	101.7	165.6	54.23	116.95	2251.67	1630.16	18.74	569.78	41.1	42.9	17.1
5	31.6	263.7	88.0	91.2	.	146.5	80.2	119.4	70.6	24.35	196.78	1009.55	3105.91	6.60	97.19	66.0	18.4	18.8
6	61.6	222.9	133.6	173.9	.	193.9	129.9	244.5	94.2	93.57	208.51	2176.32	4534.44	48.11	373.13	37.0	37.4	22.2
7	168.8	447.2	124.7	135.5	.	119.7	111.2	118.5	106.9	51.23	159.76	2550.98	3382.37	21.59	139.05	49.2	35.5	18.1
8	540.4	81.0	127.8	107.3	.	111.7	83.4	149.7	61.1	57.95	161.35	2602.13	2892.59	21.01	294.45	45.7	36.9	19.3
9	999.9	451.8	174.4	187.8	.	172.1	60.1	113.3	202.0	54.75	238.66	1947.96	2982.26	27.07	447.10	59.4	30.7	13.1

OBS	ID	KCAL1	PROT1	VITA1	ASCOR1	THIAM1	RIBO1	NIACIN1	CALCIUM1	PHOS1	IRON1	KCALR1	PROTR1	VITAR1	ASCORR1	THIAMR1	RIBOR1	SPI1	NIACINR1
10	12	2498.10	139.53	9906.6	152.54	5.05	6.91	54.30	1637.23	2155.58	26.43	106.7	317.1	247.6	254.2	505.5	576.2	.	417.6
11	13	2039.13	89.00	8619.1	165.01	1.62	2.17	21.40	811.06	1403.23	17.30	87.1	202.2	215.4	275.0	162.8	180.8	.	164.6
12	14	1912.30	67.42	6279.8	152.59	1.33	1.10	19.81	389.15	898.50	14.09	81.7	153.2	156.9	254.3	133.4	91.8	.	152.4
13	15	5684.92	249.29	17828.8	999.80	3.60	3.74	55.41	1580.22	3096.37	43.99	242.9	566.5	445.7	186.3	360.1	311.8	.	426.2
14	16	2447.44	106.53	14975.5	249.10	1.87	3.41	25.44	1576.93	2042.15	19.21	104.5	242.1	374.3	415.1	187.7	284.1	.	195.7
15	17	2320.29	98.13	8616.2	188.91	1.78	2.03	24.06	954.64	1537.86	18.33	99.1	223.0	215.4	314.8	178.8	169.2	.	185.0
16	18	1866.33	62.31	4019.4	97.73	0.96	1.56	14.72	927.26	1215.16	9.06	79.7	141.6	100.4	162.8	96.0	138.6	.	113.2
17	19	1552.63	54.08	4373.8	142.32	1.23	1.13	16.68	371.65	810.54	12.44	66.3	122.9	109.3	237.2	123.4	94.4	.	128.3
18	20	2592.46	94.97	13147.7	192.57	1.37	2.35	22.15	1065.30	1604.24	16.46	110.7	215.8	328.6	320.9	137.0	195.9	.	170.4

OBS	CALCIMR1	PHOSR1	IRONR1	FAT1	CARBO1	SODIUM1	POTAS1	SATUR1	CHOLE1	CARBPER1	FATPER1	PROTPER1	KCAL2	PROT2	VITA2	ASCOR2	THIAM2
10	204.6	267.4	146.8	73.59	322.99	4272.86	5123.95	38.69	287.22	51.7	26.5	22.3	.	.	.	.	.
11	101.3	175.4	96.1	83.04	237.35	3220.90	2908.00	30.51	537.60	46.6	36.6	17.5	1981.23	68.01	8564.3	268.01	1.31
12	48.6	112.3	78.3	73.55	250.45	3016.86	2497.94	22.90	280.30	52.4	34.6	14.1	1908.90	67.34	12085.7	269.61	1.54
13	197.5	387.0	439.9	245.45	630.40	6998.48	70.25	103.23	1000.15	44.4	39.0	17.5	3399.65	77.40	2901.3	28.01	1.76
14	197.1	255.2	192.1	94.99	300.17	4489.38	4379.80	31.86	578.10	49.1	34.9	17.4	1792.14	71.45	6527.5	199.50	1.36
15	119.3	192.2	101.8	107.19	244.49	4475.60	3275.04	37.99	580.79	42.1	41.6	16.0	1869.51	70.39	5873.3	174.39	1.24
16	115.9	151.8	50.3	84.12	203.01	2804.12	2535.23	32.16	254.10	43.5	40.6	13.4	2071.78	92.82	4456.6	33.32	1.01
17	46.4	101.3	124.4	61.37	198.70	2411.44	2151.72	21.30	291.37	51.2	35.6	13.9	2521.08	75.87	7671.0	340.39	1.83
18	133.1	200.5	164.6	108.33	321.05	3696.09	3377.19	39.01	599.59	49.5	37.6	14.7	.	.	.	.	.

OBS	RIBO2	NIACIN2	CALCIUM2	PHOS2	IRON2	KCALR2	PROTR2	VITAR2	ASCORR2	THIAMR2	RIBOR2	SPI2	NIACINR2	CALCIMR2	PHOSR2	IRONR2	FAT2	CARBO2	SODIUM2
10	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
11	1.79	13.98	883.97	1751.58	12.81	84.6	154.5	214.1	446.6	130.9	149.0	.	107.5	110.4	218.9	71.1	76.33	264.17	3189.87
12	1.30	21.57	523.70	995.41	15.43	81.5	153.0	302.1	449.3	154.4	108.4	.	165.9	65.4	124.4	85.7	67.63	268.92	3845.77
13	1.50	22.96	485.99	1504.33	19.63	145.2	175.9	72.5	46.6	176.5	125.5	.	176.6	60.7	188.0	196.3	145.51	448.58	7214.49
14	1.86	18.35	883.40	1252.24	12.95	76.5	162.3	163.1	332.5	136.7	155.2	.	141.1	110.4	156.5	129.5	68.27	229.47	3649.29
15	1.40	18.63	605.34	1100.18	15.49	79.8	159.9	146.8	290.6	124.2	116.8	.	143.3	75.6	137.5	86.0	79.02	222.46	3385.99
16	1.66	18.95	779.07	1380.74	12.58	88.5	210.9	111.4	55.5	101.4	138.9	.	145.8	97.3	172.5	69.9	109.04	172.74	2970.48
17	1.75	23.24	775.15	1542.93	17.58	107.7	172.4	191.7	567.3	103.1	146.3	.	178.7	96.8	192.8	175.8	89.95	362.93	3881.95
18	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.

OBS	POTAS2	SATUR2	CHOLE2	CARBPER2	FATPER2	PROTPER2	KCAL3	PROT3	VITA3	ASCOR3	THIAM3	RIBO3	NIACIN3	CALCIUM3	PHOS3	IRON3	KCALR3	PROTR3
10	.	.	.	.	.	.	982.23	46.56	5339.9	12.03	0.45	0.54	10.40	165.99	488.52	6.94	41.9	105.8
11	2607.87	25.18	471.83	53.3	34.7	13.7	926.54	24.06	2053.7	154.35	0.78	0.49	7.56	192.58	582.42	6.65	39.5	54.7
12	3264.56	18.99	239.44	56.3	31.9	14.1	2137.61	62.90	14439.6	222.31	1.46	1.07	18.09	513.94	1031.29	20.97	91.3	142.9
13	2876.07	50.66	509.80	52.8	38.5	9.1	1629.69	51.35	1788.1	148.27	0.87	0.94	16.08	275.50	609.38	9.97	69.6	116.7
14	2873.80	23.53	279.10	51.2	34.3	15.9	1844.15	55.02	11170.4	196.32	2.98	3.62	40.24	652.00	892.24	37.32	78.8	125.0
15	2580.69	26.42	507.55	47.6	38.0	15.1	1070.14	31.31	3682.1	170.62	0.81	1.01	7.01	504.12	281.29	8.43	45.7	71.1
16	2123.14	44.00	494.07	33.3	47.4	17.9	1928.26	87.98	1783.1	40.18	0.36	0.91	16.10	759.35	1139.55	10.27	82.4	199.9
17	3480.18	30.11	380.90	57.6	32.1	12.0	1310.20	50.50	1034.8	85.53	0.90	0.90	13.30	259.45	666.46	11.51	55.9	114.7
18	.	.	.	.	.	.	1951.34	97.83	5686.3	34.85	1.24	1.98	25.13	911.90	1398.20	10.83	83.3	222.3

OBS	VITAR3	ASCORR3	THIAMR3	RIBOR3	SPI3	NIACINR3	CALCIMR3	PHOSR3	IRONR3	FAT3	CARBO3	SODIUM3	POTAS3	SATUR3	CHOLE3	CARBPER3	FATPER3	PROTPER3
10	133.4	20.0	45.5	45.1	.	80.0	20.7	61.0	69.4	43.67	103.80	1657.23	792.86	18.25	198.66	42.3	40.0	19.0
11	51.3	257.2	77.9	41.4	.	58.1	24.0	72.8	36.9	35.76	131.73	2690.35	1580.97	10.92	286.65	56.9	34.7	10.4
12	360.9	370.5	146.3	89.4	.	139.1	64.2	128.9	116.5	57.25	363.32	3184.54	4127.09	20.41	114.30	68.0	24.1	11.8
13	44.7	247.1	87.1	79.0	.	123.7	34.4	76.1	99.7	76.27	191.50	2509.14	2555.21	11.79	78.48	47.0	42.1	12.6
14	279.2	327.2	298.4	302.0	.	309.5	81.5	111.5	373.2	72.84	251.70	2676.65	1924.09	15.12	213.70	54.6	35.5	11.9
15	92.0	284.3	81.8	84.4	.	53.9	63.0	35.1	46.8	45.74	117.78	1803.02	1058.01	9.17	314.59	44.0	38.5	11.7
16	44.5	66.9	36.8	76.1	.	123.8	94.9	142.4	57.0	124.68	120.86	1400.38	2214.87	63.90	291.51	25.1	58.2	18.3
17	25.8	142.5	90.8	75.4	.	102.3	32.4	83.3	115.1	36.49	201.97	1048.49	1364.52	10.63	384.99	61.7	25.1	15.4
18	142.1	58.0	124.1	165.3	.	193.3	113.9	174.7	108.3	104.41	163.19	3268.39	2444.79	39.99	584.44	33.5	40.2	20.1

OBS	ID	KCAL1	PROT1	VITA1	ASCOR1	THIAM1	RIBO1	NIACIN1	CALCIUM1	PHOS1	IRON1	KCALR1	PROTR1	VITAR1	ASCORR1	THIAMR1	RIBOR1	SPI1	NIACINR1
19	21	2186.87	93.83	7943.2	154.33	1.34	2.13	21.49	1091.53	1543.08	17.02	93.4	213.2	198.5	257.2	134.6	178.2	.	165.3
20	22	2665.27	91.83	6832.3	144.11	1.87	1.81	27.88	647.88	1393.75	19.25	113.9	208.7	170.8	240.1	187.3	151.2	.	214.5
21	23	2439.05	87.25	6404.1	57.26	2.17	2.34	24.07	936.44	1436.18	17.93	104.2	198.3	160.1	95.4	217.4	195.5	.	185.1
22	24	1914.81	97.50	13587.0	153.04	1.68	3.71	19.06	2078.75	2186.24	14.28	81.8	221.6	339.6	255.0	168.2	309.3	.	146.6
23	25	3009.59	128.86	5489.8	111.89	1.99	3.39	28.70	1863.09	2345.71	16.86	128.6	292.8	137.2	186.4	199.0	282.7	.	220.7
24	26	2101.86	102.15	11184.2	195.54	1.66	2.58	26.47	1146.72	1736.12	20.42	89.8	232.1	279.6	325.9	160.6	215.3	.	203.6
25	27	1517.75	56.07	8087.3	187.01	1.47	1.65	17.51	726.71	1007.70	13.06	64.8	127.4	202.1	311.6	147.6	137.8	.	134.7
26	28	5155.76	227.74	16854.3	163.68	2.94	5.71	45.50	2940.95	4061.81	34.10	220.3	517.6	421.3	272.8	294.8	475.9	.	350.0
27	29	1511.73	63.25	4909.8	79.93	1.19	1.62	22.00	743.79	1167.00	13.98	66.3	143.7	122.7	133.2	118.9	135.6	.	169.2

OBS	CALCIMR1	PHOSR1	IRONR1	FAT1	CARBO1	SODIUM1	POTAS1	SATUR1	CHOLE1	CARBPER1	FATPER1	PROTPER1	KCAL2	PROT2	VITA2	ASCOR2	THIAM2
19	136.4	192.8	94.5	91.18	255.18	3602.98	3696.05	34.91	456.76	46.7	37.5	17.2	1542.51	45.11	6160.2	158.74	1.06
20	80.9	174.2	106.9	112.83	324.49	4085.66	3325.82	41.56	425.54	48.7	38.1	13.8	2607.29	82.62	6201.1	107.03	1.63
21	117.0	179.5	179.3	100.04	299.47	4839.25	2471.93	35.41	355.88	49.1	36.9	14.3	2238.14	75.00	7028.3	158.75	1.78
22	259.8	273.2	142.8	62.36	252.36	2937.56	4620.75	19.46	216.69	52.7	29.3	20.4	1503.89	65.72	7634.0	236.39	1.24
23	232.8	293.2	93.7	121.81	355.21	3963.65	4302.71	44.58	382.47	47.2	36.4	17.1	2212.20	96.84	5308.8	120.38	1.37
24	143.3	217.0	204.1	78.36	250.81	3758.49	4030.23	29.24	527.62	47.7	33.6	19.4	1558.64	77.48	6047.3	124.99	1.20
25	90.8	125.9	130.6	37.54	246.55	2851.64	2503.29	14.16	146.19	65.0	22.3	14.8	1583.24	63.77	6788.6	95.39	1.40
26	367.6	507.7	189.4	281.22	428.63	7929.59	7112.71	116.18	2024.55	33.3	49.1	17.7	4832.37	193.97	13613.5	186.80	2.94
27	92.9	145.8	139.8	53.46	192.95	2717.81	2835.44	20.12	329.09	49.7	31.0	16.3	1625.27	90.39	5126.0	137.24	1.23

OBS	RIBO2	NIACIN2	CALCIUM2	PHOS2	IRON2	KCALR2	PROTR2	VITAR2	ASCORR2	THIAMR2	RIBOR2	SPI2	NIACINR2	CALCIMR2	PHOSR2	IRONR2	FAT2	CARBO2	SODIUM2
19	1.11	16.29	447.06	827.24	14.24	65.9	102.5	154.0	264.5	106.5	92.6	.	125.3	55.8	103.4	79.1	44.94	242.26	1866.90
20	1.70	19.81	638.37	1293.83	16.31	111.4	187.7	155.0	178.3	163.3	141.9	.	152.4	79.7	161.7	90.6	121.41	301.02	4019.62
21	1.79	20.16	998.80	1385.97	17.53	95.6	170.4	175.7	264.5	178.2	149.4	.	155.1	124.8	173.2	175.3	89.70	287.56	4139.95
22	1.75	18.35	640.51	1041.54	14.08	64.2	149.3	190.8	393.9	124.4	146.4	.	141.1	80.0	130.1	140.7	55.80	188.96	2140.81
23	2.45	21.19	1327.20	1768.67	13.38	90.2	220.0	132.7	200.6	137.4	204.1	.	163.0	165.9	221.0	74.3	78.30	259.93	3133.67
24	2.04	18.91	918.05	1272.70	14.09	66.6	176.1	151.1	208.3	120.2	170.7	.	145.4	114.7	157.0	140.9	57.71	182.26	2406.03
25	1.33	21.09	391.15	903.24	14.31	67.6	144.9	169.7	158.9	140.1	111.1	.	162.2	48.8	112.9	143.1	46.83	231.44	3019.87
26	5.00	41.51	2368.53	3404.88	32.11	206.5	440.8	340.3	311.3	294.6	417.0	.	319.3	296.0	425.6	178.4	236.65	484.21	7481.90
27	1.95	22.01	1044.20	1569.66	16.27	69.4	205.4	128.1	228.7	123.8	163.1	.	169.3	130.5	196.2	162.7	57.41	179.82	2657.98

OBS	POTAS2	SATUR2	CHOLE2	CARBPER2	FATPER2	PROTPER2	KCAL3	PROT3	VITA3	ASCOR3	THIAM3	RIBO3	NIACIN3	CALCIUM3	PHOS3	IRON3	KCALR3	PROTR3
19	3179.52	15.42	253.16	62.8	26.2	11.7	1017.92	32.56	862.8	50.58	0.42	0.55	8.64	167.31	396.90	6.88	43.5	74.0
20	2385.25	43.46	586.79	46.2	41.9	12.7	1564.20	40.03	1074.5	118.07	1.36	1.06	12.05	366.49	686.85	6.37	66.8	90.9
21	3030.48	30.02	242.13	51.4	36.1	13.4	1024.25	34.04	1998.1	15.80	0.94	0.74	12.40	353.14	597.23	8.58	43.7	77.3
22	2853.07	20.49	317.79	50.3	33.4	17.5	1261.75	61.56	3761.5	145.34	1.32	1.48	20.16	253.12	867.24	15.58	53.9	139.9
23	3507.81	28.91	266.44	49.2	33.4	18.3	2094.90	75.66	4616.6	19.20	0.89	1.60	17.64	884.46	1200.11	10.88	89.5	171.9
24	2517.33	23.48	315.25	46.8	33.3	19.9	1303.38	85.98	3824.4	10.32	1.03	2.37	28.39	1519.01	1727.07	10.62	55.7	195.4
25	2081.97	15.45	171.35	58.5	26.6	16.1	1369.19	68.26	15633.5	106.78	1.20	2.30	15.46	589.47	1147.13	16.34	58.5	155.1
26	6231.96	96.24	1580.17	40.1	44.1	16.1	2266.37	100.81	16606.4	99.52	1.59	3.10	16.03	1886.65	1910.80	11.21	96.8	229.1
27	3463.88	20.40	594.21	44.3	31.8	22.2	1368.95	83.32	2221.1	54.90	0.88	1.62	25.43	929.32	1372.23	8.31	58.5	189.3

OBS	VITAR3	ASCORR3	THIAMR3	RIBOR3	SPI3	NIACINR3	CALCIMR3	PHOSR3	IRONR3	FAT3	CARBO3	SODIUM3	POTAS3	SATUR3	CHOLE3	CARBPER3	FATPER3	PROTPER3
19	21.5	84.2	42.6	46.4	.	66.4	20.9	49.6	38.2	34.95	131.32	1197.36	1298.35	14.04	114.93	51.6	30.9	12.8
20	26.8	196.7	136.3	88.5	.	92.7	45.8	85.8	35.4	73.28	202.50	2861.46	2764.13	29.78	100.83	51.8	42.2	10.2
21	49.9	26.3	94.8	62.4	.	95.4	44.1	74.6	85.8	42.70	133.94	1756.03	1122.36	13.46	42.72	52.3	37.5	13.3
22	94.0	242.2	132.0	123.4	.	155.1	31.6	108.4	155.8	52.38	151.17	1947.97	2343.68	16.91	295.93	47.9	37.4	19.5
23	115.4	32.0	89.5	133.8	.	135.7	110.5	150.0	60.4	82.68	270.97	2825.54	2579.61	30.84	236.99	51.7	35.5	14.4
24	95.6	17.2	103.6	198.0	.	218.3	189.8	215.8	106.2	48.59	133.43	2839.04	3057.54	17.22	309.46	40.9	33.6	26.4
25	390.8	311.3	120.7	191.6	.	118.9	73.6	143.3	163.4	31.05	216.97	2869.80	3472.60	10.52	330.31	63.4	20.4	19.9
26	415.1	165.8	159.0	258.4	.	123.3	235.8	238.8	62.2	101.54	245.76	3091.98	3586.32	54.51	344.28	43.4	40.3	17.8
27	55.5	91.5	88.6	135.1	.	195.6	116.1	171.5	83.1	44.80	162.89	1819.40	3926.88	14.83	388.25	47.6	29.4	24.3

OBS	ID	KCAL1	PROT1	VITA1	ASCOR1	THIAM1	RIBO1	NIACIN1	CALCIUM1	PHOS1	IRON1	KCALR1	PROTR1	VITAR1	ASCORR1	THIAMR1	RIBOR1	SPI1	NIACINR1
28	30	1391.41	50.37	7270.7	203.64	1.01	1.44	11.61	760.09	934.23	9.50	59.4	114.4	181.7	339.4	101.2	120.0	.	89.3
29	31	2009.51	86.63	8295.1	164.15	1.24	1.54	19.78	637.50	1245.72	16.71	85.4	154.6	165.9	273.5	103.4	110.5	.	123.6
30	32	2109.65	74.16	6288.3	144.15	1.64	1.98	27.03	855.96	1320.73	16.78	84.3	168.5	157.2	240.2	164.0	165.1	.	207.9
31	33	1846.28	62.99	3957.2	120.59	1.14	1.23	15.56	561.32	1002.70	10.47	78.9	143.1	98.9	200.9	114.7	102.6	.	119.6
32	34	1717.87	80.04	6059.4	118.93	1.15	2.05	16.88	1133.81	1430.38	12.65	73.4	181.9	151.4	198.2	115.7	171.4	.	129.8
33	35	3856.01	165.51	14421.1	137.46	2.08	5.74	27.93	3241.04	3587.64	22.61	190.7	376.1	360.5	229.1	208.0	478.7	.	214.8
34	36	2142.79	100.28	5796.3	38.92	1.16	2.04	17.57	857.93	1462.06	15.21	91.5	227.9	144.9	64.8	116.1	170.2	.	135.1
35	37	1844.42	69.95	4676.6	182.38	1.43	1.50	18.55	641.17	1090.53	13.98	78.8	158.9	116.9	303.9	143.1	125.1	.	142.7
36	38	2375.09	111.68	8049.9	126.87	1.77	3.08	22.03	1472.54	1883.17	16.40	101.4	253.8	201.2	211.4	177.4	256.6	.	169.4

OBS	CALCIMR1	PHOSR1	IRONR1	FAT1	CARBO1	SODIUM1	POTAS1	SATUR1	CHOLE1	CARBPER1	FATPER1	PROTPER1	KCAL2	PROT2	VITA2	ASCOR2	THIAM2	RIBO2
28	95.0	116.7	95.0	49.23	193.96	2011.34	2290.98	18.32	225.04	55.8	31.8	14.5	1548.73	62.91	6976.7	213.88	1.13	1.53
29	79.6	155.7	167.0	99.34	198.37	3842.19	3034.21	34.61	627.86	39.5	44.5	17.2	.	.	.	.	.	.
30	106.9	166.0	167.7	95.48	239.23	3062.71	3602.46	34.01	310.97	45.4	40.7	14.1	1686.58	58.83	6200.7	124.48	1.27	1.80
31	70.1	125.3	58.1	94.88	186.00	3350.52	2210.50	32.04	240.05	40.3	46.2	13.6	2936.71	112.22	9965.3	184.34	2.46	3.02
32	141.7	178.7	126.5	81.54	168.64	2599.79	2648.23	33.76	378.28	39.3	42.7	18.6	1308.58	55.28	5017.7	99.24	0.95	1.15
33	405.1	448.4	226.1	167.05	423.00	5481.55	6796.30	77.99	1264.55	43.9	39.0	17.2	.	.	.	.	.	.
34	107.2	182.7	152.1	112.29	180.89	3387.29	2401.24	42.45	898.53	33.8	47.2	18.7	.	.	.	.	.	.
35	80.1	136.3	77.6	82.80	209.15	2939.62	2651.63	29.46	511.75	45.4	40.4	15.2	.	.	.	.	.	.
36	184.0	235.3	91.1	101.11	257.12	4174.00	3157.77	42.05	471.13	43.3	38.3	18.8	2088.86	91.99	5859.9	129.43	1.54	1.88

OBS	NIACIN2	CALCIUM2	PHOS2	IRON2	KCALR2	PROTR2	VITAR2	ASCORR2	THIAMR2	RIBOR2	SPI2	NIACINR2	CALCIMR2	PHOSR2	IRONR2	FAT2	CARBO2	SODIUM2
28	14.63	789.72	1077.25	10.48	66.1	142.9	174.4	356.4	113.5	128.0	.	112.6	98.7	134.6	104.8	62.87	190.41	2331.84
29	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
30	22.51	761.03	1105.46	14.05	67.4	133.7	155.0	207.4	127.1	150.3	.	173.2	95.1	138.1	140.5	69.88	206.32	2512.11
31	28.45	1366.56	2047.01	23.03	125.5	255.0	249.1	307.2	246.8	252.0	.	218.8	170.8	255.8	127.9	109.52	375.39	5303.66
32	12.89	503.03	835.68	10.53	55.9	125.6	125.4	165.3	94.9	96.3	.	99.2	62.8	104.4	105.3	59.50	138.60	2131.18
33	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
34	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
35	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.
36	21.36	784.44	1356.04	16.72	89.2	209.0	146.4	215.7	154.7	156.8	.	164.3	98.0	169.5	92.9	87.12	236.27	3739.50

OBS	POTAS2	SATUR2	CHOLE2	CARBPER2	FATPER2	PROTPER2	KCAL3	PROT3	VITA3	ASCOR3	THIAM3	RIBO3	NIACIN3	CALCIUM3	PHOS3	IRON3	KCALR3	PROTR3
28	2542.09	22.99	286.72	49.2	36.5	16.3	1409.10	59.17	2003.3	117.45	0.66	1.05	19.85	529.08	829.81	6.27	60.2	134.4
29	.	.	.	.	.	.	1364.75	55.68	1955.2	77.18	0.71	0.81	11.56	342.23	816.62	10.47	58.0	99.4
30	2953.22	24.32	254.45	48.9	37.3	14.0	1243.61	60.38	5393.7	119.31	1.43	1.87	19.90	571.59	1244.27	16.06	49.7	137.2
31	3849.87	39.88	304.23	51.1	33.6	15.3	2158.66	57.90	894.5	100.32	1.39	1.04	18.22	420.42	1103.94	9.05	92.2	131.5
32	1654.06	23.48	264.44	42.4	40.9	16.9	1255.02	60.93	1519.7	97.95	1.18	1.21	16.78	596.59	976.30	16.08	53.6	138.4
33	.	.	.	.	.	.	1149.13	33.55	1623.4	56.82	0.98	0.38	12.21	184.08	628.97	6.58	45.9	76.2
34	.	.	.	.	.	.	1651.22	75.98	2560.4	20.76	1.20	2.00	9.35	1104.90	1332.01	6.15	70.5	172.6
35	.	.	.	.	.	.	1683.95	60.68	2595.2	169.72	1.15	1.21	17.04	472.82	1223.17	10.89	71.9	137.9
36	2452.38	33.32	407.65	45.2	37.5	17.6	1488.93	76.04	3220.2	455.03	1.27	1.80	24.83	1125.38	1322.00	10.69	63.6	172.8

OBS	VITAR3	ASCORR3	THIAMR3	RIBOR3	SPL3	NIACINR3	CALCIMR3	PHOSR3	IRONR3	FAT3	CARBO3	SODIUM3	POTAS3	SATUR3	CHOLE3	CARBPER3	FATPER3	PROTPER3
28	50.0	195.7	66.1	87.4	.	152.6	66.1	103.7	62.7	47.43	197.21	1078.27	1735.23	14.35	173.43	56.0	30.3	16.8
29	39.1	128.6	59.4	58.3	.	72.2	42.7	102.0	104.7	64.60	146.15	1746.24	2070.25	22.15	620.40	42.8	42.6	16.3
30	134.8	198.8	143.3	156.4	.	153.1	71.4	155.5	160.6	58.72	140.78	1456.86	2920.52	26.96	406.54	45.3	42.5	19.4
31	22.3	167.2	139.4	86.8	.	140.1	52.5	137.9	50.2	89.17	293.19	3560.34	1908.21	26.23	231.17	54.3	37.2	10.7
32	37.9	163.2	118.7	101.3	.	129.0	74.5	122.0	160.8	47.52	151.81	2276.78	1766.91	22.69	172.12	48.4	34.1	19.4
33	40.5	94.7	98.1	32.2	.	93.9	23.0	78.6	65.8	46.77	158.43	2398.05	2126.74	12.15	45.54	55.1	36.6	11.7
34	64.0	34.6	120.8	167.2	.	71.9	138.1	166.5	51.5	78.23	168.73	2941.10	2394.80	36.38	230.34	40.9	42.6	18.4
35	64.8	282.8	114.9	101.2	.	131.1	59.1	152.8	60.5	85.52	184.60	2416.89	3144.15	30.97	430.53	43.8	45.7	14.4
36	80.5	75.0	127.0	150.3	.	191.0	140.6	165.2	59.4	58.78	166.93	3112.44	1754.38	31.40	246.42	44.8	35.5	20.4

OBS	ID	KCAL1	PROT1	VITA1	ASCOR1	THIAM1	RIBO1	NIACIN1	CALCIUM1	PHOS1	IRON1	KCALR1	PROTR1	VITAR1	ASCORR1	THIAMR1	RIBOR1	SPI1	NIACINR1
37	39	2192.07	81.69	9059.9	82.55	1.35	2.09	27.20	833.19	1383.50	18.63	93.6	185.6	226.4	137.5	135.0	174.7	.	209.2
38	41	2435.48	107.45	10997.6	159.13	2.01	3.39	25.94	1582.06	1945.93	17.81	104.0	244.2	274.9	265.2	201.4	283.2	.	199.5
39	42	2317.59	101.36	5693.2	144.93	1.49	2.39	22.02	1109.01	1695.75	16.08	99.0	230.3	142.3	241.5	149.6	199.5	.	169.3
40	43	3396.66	142.92	8565.2	223.07	2.51	3.21	32.68	1408.65	2268.79	26.29	135.7	324.8	214.1	371.7	251.7	267.4	.	251.3
41	44	1986.88	87.93	4306.8	34.31	1.18	2.44	16.36	1354.39	1527.77	10.22	84.9	199.8	107.6	57.1	118.0	203.3	.	125.8

OBS	CALCIMR1	PHOSR1	IRONR1	FAT1	CARBO1	SODIUM1	POTAS1	SATUR1	CHOLE1	CARBPER1	FATPER1	PROTPER1	KCAL2	PROT2	VITA2	ASCOR2	THIAM2	RIBO2
37	104.1	172.9	103.5	103.84	230.54	3209.85	3565.69	37.79	588.94	42.1	42.6	14.9	2436.89	83.40	6243.3	147.23	1.77	2.24
38	197.7	243.2	178.0	108.57	263.26	4795.97	3744.01	38.25	401.59	43.2	40.1	17.6	1738.19	88.09	10793.2	239.03	1.55	2.17
39	138.6	211.9	89.3	98.88	259.00	3418.00	2992.84	38.87	448.71	44.7	38.4	17.5	1913.33	81.32	6211.6	109.67	1.22	2.03
40	176.0	283.5	146.0	130.29	427.52	4735.95	6144.79	49.93	534.81	50.3	34.5	16.8	2751.21	128.00	8508.0	158.46	2.18	2.84
41	169.2	203.4	102.2	107.75	168.54	2601.46	2703.58	42.57	592.30	33.9	48.8	17.7	.	.	.	.	.	.

OBS	NIACIN2	CALCIUM2	PHOS2	IRON2	KCALR2	PROTR2	VITAR2	ASCORR2	THIAMR2	RIBOR2	SPI2	NIACINR2	CALCIMR2	PHOSR2	IRONR2	FAT2	CARBO2	SODIUM2
37	28.10	873.98	1444.13	18.37	104.1	189.5	156.0	245.3	177.4	186.8	.	216.2	109.2	180.5	102.0	112.28	277.57	4430.73
38	22.45	953.82	1399.47	15.75	74.2	200.2	269.8	398.3	155.7	181.5	.	172.7	118.2	174.9	87.5	69.96	195.45	3650.28
39	17.65	953.38	1359.28	12.60	81.7	184.8	155.2	182.7	122.3	169.8	.	135.7	119.1	169.9	70.0	90.44	196.72	3009.02
40	30.56	1328.23	2014.35	21.99	109.9	290.9	212.7	264.1	218.1	237.0	.	235.1	166.0	251.7	122.1	111.66	302.67	5157.14
41	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.

OBS	POTAS2	SATUR2	CHOLE2	CARBPER2	FATPER2	PROTPER2	KCAL3	PROT3	VITA3	ASCOR3	THIAM3	RIBO3	NIACIN3	CALCIUM3	PHOS3	IRON3	KCALR3	PROTR3
37	3485.56	36.83	359.37	45.6	41.5	13.7	1059.68	62.00	11543.7	65.50	0.92	1.15	14.75	475.74	888.99	8.70	45.2	140.9
38	3456.78	25.64	351.83	45.0	36.2	20.3	2064.06	87.97	9584.6	56.17	1.71	2.22	31.47	902.22	1325.15	10.73	88.2	199.9
39	2783.43	34.77	396.20	41.1	42.5	17.0	2343.28	96.09	2618.4	60.11	1.12	2.34	10.46	1335.17	1529.06	10.17	100.1	218.3
40	3956.46	43.13	493.99	44.0	36.5	18.6	1407.69	78.77	1786.1	94.97	1.05	1.58	13.86	1017.27	1332.17	11.34	56.2	179.0
41	.	.	.	.	.	.	1328.92	54.66	1214.2	7.81	0.70	1.25	11.77	502.34	876.58	9.41	56.7	124.2

OBS	VITAR3	ASCORR3	THIAMR3	RIBOR3	SPI3	NIACINR3	CALCIMR3	PHOSR3	IRONR3	FAT3	CARBO3	SODIUM3	POTAS3	SATUR3	CHOLE3	CARBPER3	FATPER3	PROTPER3
37	288.5	109.1	91.9	96.2	.	113.5	59.4	111.1	48.3	51.33	91.54	3019.72	2791.90	20.54	213.61	34.6	43.6	23.4
38	239.6	93.6	171.6	185.1	.	242.1	112.7	165.6	107.3	82.54	253.74	3186.03	3196.00	27.34	231.02	49.2	36.0	17.0
39	65.4	100.1	112.3	195.6	.	80.4	166.8	191.1	56.5	106.27	257.95	1660.72	2605.32	54.72	316.02	44.0	40.8	16.4
40	44.6	158.2	104.9	132.1	.	106.6	127.1	166.5	63.0	56.54	151.49	1566.11	2075.54	14.01	318.57	43.0	36.1	22.4
41	30.3	13.0	70.3	104.3	.	90.5	62.7	109.5	94.1	71.36	120.36	1804.95	1686.35	33.12	458.32	36.2	48.3	16.5

VALIDITY AND RELIABILITY OF A FOOD FREQUENCY QUESTIONNAIRE

by

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B.F.A., Washburn University of Topeka, 1981

AN ABSTRACT OF A MASTER'S THESIS

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ABSTRACT

The validity and reliability of a food frequency questionnaire was tested with rural Kansas homemakers who were participating in a Jackson County farm survey. A food frequency questionnaire was mailed to 41 subjects in November 1986 requesting them to estimate their intake of selected food items for the previous month. During a home visit questions were answered regarding the food frequency questionnaire; at the same time a 24-hour dietary recall was obtained. To test validity of the food frequency questionnaire estimated mean intakes for energy and eight nutrient were compared to mean estimated intakes obtained with the 24-hour dietary recall. Although the two instruments produced similar ($p<0.05$) mean estimates of vitamin A, calcium, and iron intakes, data on energy and five of the eight nutrients studied were not in good agreement. The food frequency questionnaire estimated higher mean intakes for energy and all nutrients studied when compaired with the 24-hour dietary recall. No statistically significant correlation was found between the food frequency questionnaire and the 24-hour dietary recall for energy and the eight nutrients studied. In conclusion we found that the two instruments when administered to a group of rural homemakers did give similar mean estimates of energy and

selected nutrients intakes.

In a test of the reliability the food frequency questionnaire 33 of the same subjects completed the instrument again after four months and comparisons were made between the two food frequency questionnaires. The mean intakes of vitamin A, ascorbic acid, thiamin, and iron did not differ significantly. Energy and all other nutrients showed no significant differences. Correlation coefficients ranged from 0.75 ($p<0.0001$) to 0.51 ($p<0.002$) for energy and six of the eight nutrients studied when a food frequency questionnaire was administered four months apart. Vitamin A and ascorbic acid were the only exceptions showing relatively low correlations. In conclusion we have found the food frequency questionnaire under investigation is a reliable instrument to estimate the mean nutrient intakes of a group of rural homemakers.